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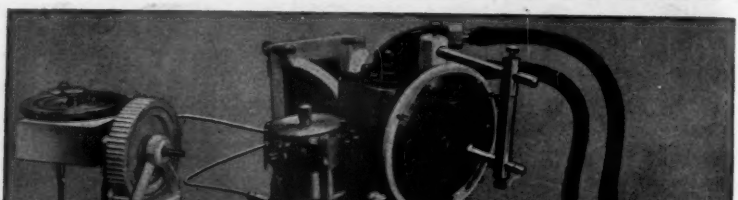

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FUEL UTILIZATION IN BRITAIN

PROF. F. E. SIMON, in articles reprinted in his recent book "The Neglect of Science", strongly attacked wasteful methods of using fuel. He believes that the shortage of coal in Britain will be a permanent feature of our economy so long as we continue to employ outmoded ways of using it which had been conditioned by a cheap and abundant supply of coal. He argues that it would be possible by energetic and appropriate action to save up to 20 million tons of coal a year in five to ten years. He also criticizes the present electricity tariff system, urging a complete reversal of its basis as well as a proper co-ordination of policy and requirements between the coal, gas and electricity industries to secure a national fuel policy for Britain. A little more reserved than *The Economist*, which has definitely advocated a sharp rise in the price of coal to check domestic consumption and stimulate its more efficient issue in industry, he favours a taxation policy to that end, especially in regard to allowances for fuel-saving equipment.

This would seem to be a matter to which the Parliamentary and Scientific Committee might well be expected to give further attention. It will be recalled that a report on the utilization of coal issued by that Committee in 1943 urging the largest possible expenditure on coal utilization research aroused wide interest and did much to stimulate a campaign to ensure better use of coal resources. In a later report issued in 1947, the Committee suggested that a plan should be worked out for the systematic comparison of the fuel consumptions of different firms engaged in the same type of work, and for the preparation of fuel efficiency indexes at which firms in any particular industry should aim. It also suggested that priority for introduction of oil-burning plant in place of coal-burning plant should be limited to those industrial purposes where use of liquid fuel is an intrinsic part of the most efficient industrial technique. A third report, also issued in 1947, which dealt mainly with the need for giving effective priority to the steel supplies required by the combustion appliance industry, lends even closer support to Prof. Simon's argument. The Committee accepted the view that an annual saving of some 18 million tons of coal a year could be achieved in industry by an adequate refitting programme involving the use of modern mechanical stokers, forced-draught furnaces, pulverized fuel firing equipment, new types of horizontal and vertical shell and water-tube boilers, and modern metallurgical and other process furnaces.

Little is said in this report about further savings which could accrue from the adoption of modern methods of domestic space- and water-heating; but two years later the administrative secretary of the Committee, Lieut.-Commander C. Powell, in an address to the Fuel Luncheon Club, indicated that the representations of the Committee had already been of substantial value. It is difficult, however, to estimate whether any real progress has been made. The use of differential tariffs and taxation to encourage economy were also tentatively suggested by Political and Economic Planning in its survey in 1947.

The two essential points that Prof. Simon makes, however, are the need for a scientific and factual approach to the problem and for a co-operative effort, by all parties, to apply whatever policy may be formulated on the basis of such a study. So far, nationalization has contributed nothing towards the formulation of a national fuel policy, though the fuel crisis of 1947 brought home to the nation the danger of its situation; and recently, after discussions with the Federation of British Industries, the Electricity Boards have agreed to waive until 1959 contractual restrictions on the use of independent generators of electricity in industry. Last July, Mr. Attlee's Government appointed a committee to examine the wider aspects of national fuel and power policy, and Mr. Churchill's Government has been sufficiently impressed with the need for fuel economy to sponsor, through the Anglo-American Productivity Council, the sending of a Productivity Team to the United States on January 31 to study the conservation of fuel.

Nevertheless, it has not yet been officially recognized, or at least admitted, that the fuel shortage is other than a temporary though a recurrent situation. The Select Committee on National Expenditure in 1943 did indeed assert that coal is the very foundation of our war effort, and Prof. Simon emphasizes both the saving of man-power—estimated as the output of 100,000 miners—which could be achieved by eliminating waste and adopting reasonable methods of heating, and the advantage of independence of foreign labour. More substantial arguments are advanced by Political and Economic Planning in a broadsheet, "Fuel Prospects" (No. 336. December 3, 1951), which points out the disparity between the long-term plans of the National Coal Board to increase coal output and the British Electricity Authority's estimates of future coal consumption. In October 1950, the "Plan for Coal" envisaged an increase in output of some 20 million tons in fourteen years time, by which date open-cast mining will have disappeared. Within this period, however, the British Electricity Authority alone expects to double its present annual consumption of 33 million tons. Political and Economic Planning believes, moreover, that apart from such estimates, fuel consumption tends generally to increase with the national income, and the new broadsheet attempts to relate the long-term possibilities of providing adequate supplies of fuel to the ways in which the shortages of the immediate future could be overcome.

Even if there is a fair prospect of increasing supplies of primary fuel in the long run, for the next few years no large increase is feasible, and the outlook for the immediate future is bleak. At present, coal output in Britain is increasing only slowly, and P.E.P. believes that the National Coal Board's longer-term production plan is inadequate. An increased rate of investment in collieries and a larger mining labour-force are essential conditions of a higher rate of output. Both are really problems of man-power, and neither can be solved quickly. The first involves getting more of the technical experts necessary to increase the scale of the Board's operations; the second is the even more urgent problem of attracting recruits to a labour-force which is no longer self-replacing.

Efficient utilization of coal should be an important element in national fuel policy, whatever the conditions of supply; but for these reasons Political and Economic Planning concludes that for the next few years greater efficiency in the use of coal must be relied upon to carry Great Britain through its difficulties. A concerted plan aimed at making the best use of the available output is required, and the broadsheet would place the main responsibility for this, and for seeing that coal is not wasted in use, on the Minister of Fuel and Power. The Minister has already the duty of promoting "economy and efficiency in the supply, distribution, use and consumption of fuel and power", but has so far interpreted this responsibility very narrowly. A radical change in the attitude of the Ministry to the nationalized industries, rather than the acquisition of new powers, is required.

The broadsheet suggests that the national interest clearly demands that the Ministry should direct the British Electricity Authority to alter its tariffs, both to discourage the wasteful use of electricity in the home and to encourage the installation of auxiliary generators by industry. It is also essential to create conditions which will induce or enable the private sector of industry and domestic coal users to act in the national interest. Accordingly, P.E.P. concedes the need for special tax relief for capital expenditure on industrial fuel-saving equipment, and a system of coal allocation which penalizes inefficient industrial use of fuel. Domestic consumers must similarly be given an incentive to use coal efficiently by reducing the consumption of electricity for space- and water-heating, and making more use of solid-fuel appliances, for example, by providing such appliances in large numbers and at low and possibly at subsidized prices.

Finally, the broadsheet emphasizes the need for more support for research on fuel efficiency by the Ministry. At present, less than 0·1 per cent of the total expenditure on fuel and power is devoted to research, and the work of the many bodies concerned is largely unco-ordinated. In particular, the fuel-saving potentialities of such developments as underground gasification of coal, diesel–electric locomotion and district-heating should be explored as matters of urgency. The return from these schemes becomes much more attractive in terms of coal saved once it is accepted that the present price of coal bears no relation to its true value. The broadsheet does not enter into technical details, either of such developments or of fuel economy in industry, but is content to indicate the broad possibilities and to emphasize the urgency of such measures and the need for vigorous concerted action.

The fuel situation in Britain could well be studied as an illuminating example of the general problem of relating knowledge and power, and even the more immediate and pressing problem of what steps could and should be taken to formulate a national fuel policy may throw some light on the general problem. Despite the need for continuing research on the

utilization of fuel, there is already ample knowledge as to the most suitable forms of fuel for particular purposes and the most efficient appliances. The major problem is to secure the use of available knowledge and the formulation and execution of a consistent national policy, instead of the contradictory policies that have often been pursued hitherto by independent bodies like the Gas Council, the National Coal Board and the British Electricity Authority. A consistent policy for domestic utilization of fuel, supported by the appropriate fiscal measures from the Chancellor of the Exchequer, would be the surest and quickest means of reducing the overload on power stations. Future plans for hydro-electric power should no more be formulated without relation to such financial support than they should without regard to the effect of the schemes on agriculture or amenity.

Open-cast coal mining provides a further illustration of the need for something more than purely departmental planning and policy. The responsibility for such mining rested with the Mines Department when such operations were first authorized by a Defence Regulation in 1942. Afterwards, in 1943, responsibility was transferred to the Ministry of Works, and in 1945 was returned to the Ministry of Fuel. While, however, as a desperate expedient during the War, winning of coal in this manner was possibly justified, it is doubtful, even if all consideration of amenity is ignored, whether Britain can really afford the loss of agricultural land for this purpose.

Moreover, apart from the effect on agricultural production through the loss of good farming land, much expensive machinery has had to be imported from abroad, and the effect on the road system of the heavy coal-lorries has not been negligible. Although the open-cast sites last year provided some eleven million tons of coal, this is a small amount compared with the 211 million tons produced in the mines, and only a fraction of what could be saved in industrial or domestic heating by more efficient methods. Now that the responsibility for such production will, from April 1 of this year, rest on the National Coal Board, there may perhaps be a better chance of open-cast coal mining being viewed in its true economic and national perspective, and a real attempt made to end what should be only a temporary expedient.

A decision to abandon open-cast working can only come on Government initiative when full weight is given to the agricultural, economic and other aspects besides that of production, and here again it is a matter of assembling technical advice and securing action thereon. Clearly the Government must give full weight to the administrative difficulties and social repercussions which would arise from the formulation and enactment of the policy which technical advice would indicate as the most desirable. What is important, however, in Britain's present situation is that policy and action should be determined on the basis of facts and not by political prejudices or sectional interests; the view of what is administratively practicable as well as technically possible should take full account of the extent to which reasoned explanation and a well-conceived campaign of education could remove prejudice and gain the support of those whose real interests the policy is to serve.

The devising and planning of a national fuel policy is an excellent illustration of the complexity of the problem of securing the full use of the men of science and technologists in the service of the State. It indicates how much more is involved than that of seeing that research is initiated on the right projects and fully supported, that the conditions are such as to attract trained men of first-class ability, and that those so engaged are able to interpret their results accurately and effectively to those who should use them. A policy of public education may well also be required, and a readiness to take a national and not a selfish point of view on the boards of public bodies, from a nationalized industry to a trade or professional association. There is also the question of the level at which technical and scientific advice is to be tendered to the Minister or other executive, and possibly also the place and relation between the research programme and policy and administrative policy to which the late Prof. H. J. Laski directed attention in one of his last lectures. Finally, above all this urgent need for fresh thought about the organization of government and the place of the expert in it, there is the need for administrators and Ministers who are qualified by their understanding of science and technology to give due weight to the representations of technical or scientific experts, not from one branch of science or technology but probably from half a dozen or more, and to assess accurately and impartially the technical or scientific factors involved in relation to the economic, social and political considerations which they must also have in mind. It is a question ultimately of the more effective utilization of scientific and technical knowledge in industry and in national affairs, upon which not only the solution of the fuel problem but also of Britain's economic and industrial future depend. To achieve this end, the positions of executive or administrative responsibility in the State must be occupied, not indeed by the expert as such, but by those who have sufficient knowledge and appreciation of science and technology to understand scientific or technical advice, and are able to use it wisely, swiftly and resolutely.

AN EXPERIMENT IN GEOPHYSICAL RESEARCH

The Thunderstorm

Report of the Thunderstorm Project. (United States Department of Commerce: Weather Bureau.) Pp. ix+287. (Washington, D.C.: Government Printing Office, 1949.) 2.25 dollars.

THE meteorologist's study of the motion of the atmosphere may be along two rather distinct lines. One, not yet much cultivated for lack of sufficiently powerful tools, may be styled the integral approach and concerns the behaviour of a system with an infinite number of degrees of freedom, the

distribution of energy in the system and its evolution in time. Opposed to this is the procedure whereby certain scales and patterns of atmospheric flow are isolated from the whole spectrum of motion for individual study, as 'things in themselves', and of such identifiable entities the convection system called cumulus, or cumulo-nimbus in the well developed state, has long exercised a fascination. It makes a direct appeal to the human pair of eyes to be treated as an 'individual', since the condensation pattern produced instantaneously by the motion is often clear cut, its production of precipitation is characteristic in intensity and often in form (hail), it creates and destroys electrical energy at rates which more than match the largest power stations, and, in the aircraft age, provides the greatest free-air flying hazards in icing and turbulence. The book under review describes a heroic attempt to come to grips with this individual, by methods of planned co-operative research which, I believe, set a pattern, in principle, for much geophysical research of the future. The individual proves now perhaps to be less individual than was earlier supposed, to have merged somewhat with his environment as an entity in time; but the grin is real enough and calls for further study, even though the cat is partly of Cheshire quality.

During the Second World War various interests—commercial and military aviation, aeronautical research, and academic and government meteorology—in the United States began to plan an intensive investigation of the thunderstorm. The decision, under special Congress authorization, to go into the field was taken in early 1945, the Weather Bureau assuming responsibility for the organization, with Dr. H. R. Byers, of the University of Chicago, as the project director. The termination of the War in August 1945 made possible the release for peace-time use of personnel, equipment and aircraft on a much more liberal scale than had earlier been considered possible, and so towards the end of the year was born the Thunderstorm Project as it is now known. In its first year (1946) of field operation, Orlando, Fla., was used as base, and in its second and last year, Wilmington, Ohio. Twenty-two railway freight cars, apart from self-mobile trucks, jeeps and aircraft, were used to transport the Project equipment from Florida to Ohio.

The investigation was aimed more at the macro-physical than the microphysical problem, at the dynamics and thermodynamics of the thundercloud as a whole rather than at the life-history of the individual condensation products and the processes by which they separate charge in the cloud. Four broadly distinct observational techniques were used. First, a roughly rectangular network of fifty-five surface meteorological stations with a separation of 1–2 miles was set up to record rainfall, temperature, pressure and wind, and, in a few cases, point-discharge current. Next came a number of *radiosonde* and radio or radar wind-stations located around the periphery of the network to provide simultaneous soundings of temperature, humidity and wind against pressure or height—the investigation of the horizontal field of wind as a function of height was rightly regarded as basic for the investigation. Then aircraft were used, being specially selected for the direct exploration of the cloud, five at any one time, and making horizontal traverses at a vertical separation of 5,000 ft. between 5,000 and 25,000 ft. Their standard navigational instruments were photographed on traverse to provide the means of deducing the velocity of updraught or downdraught, and in addition they were fitted with recording accelerometers, thermometers, and electric-field meters—but the problems of obtaining satisfactory records from the last two were not solved. The aircraft observations formed the backbone of the study, and it is good to know that in spite of hazards no loss was incurred. Finally, there was a ground radar control—plan-position and range-height indicators—for determining the horizontal and vertical patterns of precipitation in the clouds, for tracking the precipitation patterns and for locating the aircraft with respect to the precipitation echoes. Records from ninety-one periods of rain in the Florida network and from eighty-eight in the Ohio network were selected for study, and the bulk of the volume under review is taken up with the results of the analysis.

This is not the place to attempt a critical résumé of the results, which have already become partly known from earlier papers. But special mention may be made of the important conclusion that the thunderstorm is no more a continuing single entity than many another atmospheric disturbance. Something has a continuing life between the birth and death of the system as a whole; but, as with a depression, it is the pattern, more or less rapidly evolving in time, and not a particular mass of air which describes a recognizable track. The thunderstorm is, in Dr. Byers's nomenclature, a sequence of self-propagating cells, each one of which goes through a life-cycle in about an hour, and several may be in existence together but at different stages in the cycle. Each cell has something of the characteristic of a fountain jet; first there appears a rising column of air with its associated condensation products, and then a falling column of precipitation and down-draught air. As the downdraught approaches and then spreads out over the ground, so another upward jet is created and the cloud propagated, by new formation as well as by travel.

The Project workers have skilfully assembled and presented a vast amount of information, and not the least merit of their publication is that they have made this information available for all who would work in the field. Their interpretation of data will be questioned on many scores, but they have used the data, and we must be grateful to them as well as to the authorities who organized and supported the venture for providing such fare. Many more data are yet required: the horizontal field of temperature as a function of height within and outside the cloud is still poorly determined; we do not yet know whether and, if so, how much subsidence takes place in the clear air around the clouds; the thermodynamic term *environment* needs to be better related to observation; electric-field measurements as a function of height and time are another obvious need; and the life-history of the condensation elements, from cloud water droplets and ice crystals to precipitating rain and hail, is still quite speculative. These and other observations will keep the subject live for many a day.

The book of the Project is more difficult to read than it need have been—a stronger editorial hand would have contrived greater coherence and less repetition. But it is a veritable scientific epic none the less. It deserves a salute both for itself and for revealing the further possibilities of planned research in a science already well used to co-operation and with no inglorious history in such effort.

P. A. Sheppard

IMMANENCE AMID TRANSCENDENCE

Humanity and Deity

By Wilbur Marshall Urban. Pp. 479. (London: George Allen and Unwin, Ltd., 1951.) 25*s*. net.

IT is good that occasionally an author should offer his book to the public with little regard to the usual formalities—the compelling reasons for writing it, the incapacity to do so, and the rest. This is fundamentally Prof. W. M. Urban's position; and the reason is that his book is almost a *cri du cœur*, needing no apology and expecting no favours. True, we find his reluctance to set forth on his quest charmingly expressed, and the natural, but all too superficial, charge of escapism (from the turmoil of the Second World War) discounted well in advance. Yet, sooner or later, wisdom is justified of her children, and this complex contribution to contemporary thought will assuredly find a permanent niche.

Readers who have not studied Prof. Urban's earlier volumes will find themselves at a disadvantage, because these pages show—it is their strength and their vulnerability combined—the characteristic urge to discover a common denominator between factors commonly, but not always correctly, assumed to be incommensurable. In this case the search is for a God who is immanent and yet transcendent. As everyone knows, there is one way, and only one, in which this is likely to be in the least successful, and that is by following the path of what is professionally known as traditional theism. Immanence left to run riot produces inevitably an irresponsible pantheism, whereas unrationed transcendentalism usually ends up in an orgy of deism, with all the attendant drawbacks inherent in the conception of the 'absentee-landlord' type of Creator. Well may we beware of the majestic but melancholic Kierkegaard, and his successors, the Barthians of our own day, constructing a religion of paradox and crisis, which seems to fit all too easily into the world of our twentieth-century experience. Not without justification did Whitehead once remark that it was the medievalists who walked by reason and the moderns by faith. Most of this is implicit in what Prof. Urban has to tell us: he tends to be somewhat repetitious in places, and to make things more difficult than he need by the habit of introducing a subject with a protracted lemma (by no means unnecessary), but omitting to be clear at what point the prolegomenon ends and the proposition he wishes to establish begins. Unluckily, there are no summaries by means of which his arguments can be clinched.

Thus, in a review of reasonable length, one is obliged to pass over in silence much erudition displayed in the discussion of language, myth, symbolism, and the axiological development as it is enmeshed—perhaps even enshrined—in the writings of the scholastics, and of the present virile exponents of Thomism. An excellent point should be noted *en route*, namely, that the law of contradiction is only applicable in a plane of discourse which has previously been agreed. It is not 'transferable'. In symbols, we should be careful to write

$$\{\sim[p \sim p]\}_{p \text{ of } d \text{ const.}}$$

rather than leaving it vague, as we are unconsciously prone to do. Much of the heat generated during the past century over the science versus religion conflict might have been largely avoided by this simple precaution. In our own day, 'what science really says', and, for that matter, 'what religion really says' are subjects only debatable with a similar restriction. In fact, Prof. Urban examines both their credentials, and sets them their bounds.

It seems likely that the main thesis—the degree of balance tolerable between immanence and transcendence—will be judged in the long run by the author's handling of the doctrine known as *analogia entis*, and by his treatment of Christian mysticism. Beside these two items, the remainder of the book is likely to be assessed as of secondary consequence, but in the nature of a treasure out of which a scribe can bring forth things new and old. Yet with the *analogia entis* we are confronted with perhaps the greatest attempt ever made by philosophical theologians to stabilize the relationship between deity and humanity; and stabilization there simply must be, if true knowledge is to abound. Two interpretations of the doctrine are possible, and common. One is that, starting from finite perfections, and following the path of empirical reasoning, the divine perfections are eventually attained. (This, by the way, is how the Thomistic principle is normally regarded.) Alternatively, it is necessary to postulate a special kind of intuition, by means of which our human attributes are modelled so as to become conformable to the Divine. An extension suggested by Prof. Urban does not appear to me to help matters a great deal, in view of the fact that a much more precise formulation—in English—is to be found in two books by E. L. Mascall (1943 and 1949) to which no reference whatever is made. This seems a curious omission, but the aims are broadly similar, namely, to assert that Deity has no need of creation, but that Creation has every need of Deity. Nobody has ever seriously suggested, in this context, that the *Deus philosophorum* is the same as the God of the Christian. The essence is that the former can never be *inconsistent* with the latter.

Towards the close, we are faced with the strain of mysticism running through all human consciousness, from which it is deduced that it forms at least an element in philosophy. Certainly we find the tendency in Plato and in Aristotle, and it can be traced in most of the Arabic thinkers before Averroës, particularly in Avicenna. If this had not been so, it would be difficult indeed to account for much we find in the outlook of St. Thomas Aquinas. Acceptance and transcendence—these have been the constant companions of the greatest mystics. Noteworthy, too, is how they have been held inviolate by two such diverse minds as those of Baron von Hügel and Earl Balfour; and during this very year are appearing the works of Edith Stein, who, starting as a pupil of Husserl, ended as a Carmelite, and sealed her conviction with the message of the *Kreuzeswissenschaft*. All this is easy to discount, but far harder to appraise in the light of modern thought. Prof. Urban does not see himself in the role of a crusader setting out to establish these experiences by formal argument: he appears to be thinking aloud, towards the evening of a long life, as if to beckon to others, skilled in epistemological symbolism, to share his strife and to enter into his calm. It is almost to exclaim, with the Queen of Sheba at the court of King Solomon, "And behold, the half was not told me".

F. I. G. RAWLINS

PHOTOSYNTHESIS

Photosynthesis and Related Processes

By Prof. Eugene I. Rabinowitch. Vol. 2, Part 1: Spectroscopy and Fluorescence of Photosynthetic Pigments; Kinetics of Photosynthesis. Pp. xi+601–1208. (New York and London: Interscience Publishers, Inc., 1951.) 15 dollars.

THE publication in 1945 of Vol. 1 of this book marked a notable contribution to our knowledge of the fundamental physiological process which is concerned with the synthesis of organic material from sunlight. Vol. 2, Part 1, of this work, which now appears, sustains the interest and value of the earlier volume.

The first part gives an account of the spectroscopy and fluorescence of photosynthetic pigments, while the kinetics of the process is dealt with in the second part. The spectroscopic properties of the pigments are described in detail, and the resulting effects of the intensity of different parts of the spectrum are described and illustrated by a series of curves which show the kinetic energy of different wave-lengths. The absorption spectra of the pigments in solution and *in vivo* are treated in great detail, and the colloidal and adsorbed chlorophyll in different media are shown to be important. This chapter ends with a good bibliography from 1913 to date with 147 entries.

A short review of light absorptions in solutions or other homogeneous media is given, and these results convey a simple interpretation in terms of molecular absorption coefficients, but the experimental determination of the absorptive powers of plants is shown to be far less simple. The measurement of the absorptive power of leaves or cell suspensions is complicated by scattering even in suspensions of single cells, because the dimensions of the cells, $\sim 10^{-3}$ cm., are larger than the wave-length of visible light, $\sim 5 \times 10^{-5}$ cm. The absorption of light by a leaf, thallus or cell suspensions has been determined, and the question of how far this absorption is due to the chloroplast pigments is considered.

The plant cells containing colouring material associated with cell walls or with the plastids, such as flavones, tannins, are only weakly coloured; but in cases where the flavones and anthocyanins are abundant much of the light energy is absorbed by non-plastid pigments. From this it follows that a leaf spectrum is not the true spectrum of the pigment against wave-length. This is supported by the absorptive spectrum of many types of leaves and the absorptive spectra of chloroplast suspensions.

The chapter on the internal and external factors in photosynthesis contains an analysis of the distortion of light curves and carbon dioxide curves, and this is followed by general consideration of the kinetics of the process. The statement that photosynthesis is not a homogeneous reaction is treated at length, and the sources of saturation by a number of curves; the opening and closing of the stomata and the effect on the carbon dioxide curves are considered in detail. The intensity of the light factor, the intensity of the maximum rate and the inhomogeneity of the light absorption are shown to be of great importance.

The last chapters deal with the light factor as regards intensity and the maximum quantum yield, and in this connexion the role of accessory pigments and the photosynthesis of red and blue algæ. The work ends with an authors' index of the main investigations described in Vol. 2, Part 1, with detailed references to 352 authors whose researches are discussed in this book.

This book stands as a conspicuous contribution to the study of photosynthesis, profusely illustrated with diagrams and tables. The author enters fully into the quantum aspect of this most complex process, which acts under such an immense variety of conditions. If a word of criticism could be added it would be to wish the author had included a brief résumé at the end of each chapter. We may hope that this will be done in Part 2 of Vol. 2.

F. J. Lewis

BIRDS OF WEST AFRICA

The Birds of Tropical West Africa

With Special Reference to those of the Gambia, Sierra Leone, the Gold Coast and Nigeria. By Dr. David Armitage Bannerman. Vol. 8. Pp. xxiv+552. (London: Crown Agents for the Colonies, 1951.) 50*s*. net.

THIS volume, a supplement to the preceding seven, completes Dr. D. A. Bannerman's account of the birds of tropical West Africa. The work as a whole represents many years of devoted labour on the part of an acknowledged authority on the ornithology of the area; and, in addition to his original contributions to the subject, it brings together the information obtainable from earlier published sources and by personal communication with many other observers and collectors.

From a general point of view, the completed work is welcome because it fills in an important segment of the ornithological map, so to speak, of the world. It is a segment of special interest, being the tropical area nearest to the western palæarctic countries. It is also an area providing a wide variety of environments, from desert and montane, through savannah and grass-woodland, to equatorial forest and mangrove swamp; and, as Lord Passfield pointed out in his preface to the first volume, the thorough exploration of much of the area is of recent date.

From a local point of view the work provides the obvious base-line for all further study. A primary aim has been to facilitate such study by providing aids to identification, in the form of descriptions of all forms, numerous illustrations and a diagnostic key. The size of the work makes it more suitable for the library than for use in the field; it is therefore good news that a condensed edition, in three volumes of handbook size, is being prepared.

The avifauna is a rich one. Close on eleven hundred species, comprising more than fifteen hundred forms that are either specifically or racially distinct, are dealt with in the work. They include, of course, not only peculiarly Ethiopian birds but also many of wider range and migrants from the palæarctic region which do not breed in the area. The distribution of some three-quarters of the total number of species extends into other parts of Africa, where the work will therefore also have its uses.

Publication of the work would in any event have taken several years to complete; but the interruption of war has extended the period beyond all expectation. The first volume appeared in 1930, and by 1939 five were available; but then followed a gap of nine years. As a consequence, a great deal of new information relating to the subjects of the earlier

volumes had come to hand before the end, and this is presented in the final instalment. Apart from additional facts about birds already included, a score of species not previously recorded in the area are now dealt with in full, and likewise a slightly larger number of further racial forms of species which were otherwise represented. General indexes to the whole work, under scientific and common names respectively, are included in this eighth volume.

Dr. Bannerman is to be warmly congratulated on his achievement; he has added a classic to ornithological literature. Credit is also due to the printers for the excellent production, well maintained in the later volumes despite new difficulties. One must also mention the support given to the project by the Colonial Office and the Governments of the four British territories in West Africa; to the co-operation given by them throughout, and by the Crown Agents for the Colonies, the author pays a very cordial tribute in his final preface.

A. LANDSBOROUGH THOMSON

SEMICONDUCTORS

Electrons and Holes in Semiconductors

With Applications to Transistor Electronics. By William Shockley. (Bell Telephone Laboratories Series.) Pp. xxiii+558. (New York: D. Van Nostrand Co., Inc.; London: Macmillan and Co., Ltd., 1951.) 73*s*. 6*d*. net.

Semi-Conducting Materials

Proceedings of a Conference held at the University of Reading under the auspices of the International Union of Pure and Applied Physics in co-operation with the Royal Society. Edited by Dr. H. K. Henisch. Pp. xv+281. (London: Butterworths Scientific Publications, Ltd., 1951.) 40*s*.

THE present interest in semiconductors largely springs from technological origins: the war-time demand for efficient crystal mixers at microwave frequencies, the subsequent development of the high back-voltage germanium rectifier, the discovery of photoconductive materials with a response extending far into the infra-red, and, most recently, the invention of the semiconductor amplifier or transistor. This last device is a spectacular example of a technical product which has emerged from fundamental research in solid-state physics. Since the public announcement of the transistor by the Bell Telephone Laboratories in June 1948, an intensive study of the underlying processes coupled with the development of a variety of practical devices has continued without interruption. Dr. William Shockley, of the solid-state physics group at the Bell Telephone Laboratories, has provided much of the theoretical inspiration and interpretation for the transistor, and the great volume of published work from this group has contributed very significantly to our understanding of conduction, rectification and amplification in semiconductors.

It is therefore particularly gratifying that Dr. Shockley has now provided a connected and critical account of transistor electronics, and in so doing has presented a modern treatise on semiconductors. The theoretical treatment is general in its application, but, not unnaturally, it is exemplified particularly by reference to germanium and silicon. The book is divided into three parts. Part 1, entitled "Introduction to Transistor Electronics", describes in simple terms the concept of conduction by electrons and holes and their injection into germanium, the properties of *p–n* junctions, and both the type-*A* and junction transistors. Part 2, "Descriptive Theory of Semiconductors", presents the elementary quantum theory of energy-levels in crystals and, with the aid of the Brillouin zone concept, leads to a consideration of the motion of electrons and holes in electric and magnetic fields. The last chapter of this part deals with a number of important topics, including the discrepancy between the drift and Hall mobilities and a proposed theory of noise generation in germanium. Part 3, "Quantum Mechanical Foundations", develops in more detail the mathematical theory of the wave-functions of electrons and holes and their behaviour in a crystal in the presence of electric and magnetic fields. An interesting attempt is made to present the mathematical abstractions in terms of transmission-line analogues which may prove valuable to those readers who think more readily in terms of equivalent circuits.

Dr. Shockley's book gives evidence throughout of careful planning; the diagrams are excellent, the mathematical results are amply illustrated by numerical examples, and a pleasing feature is the setting of problems at the ends of most of the chapters. This book can be unreservedly recommended to all who are concerned with semiconductors and to those who wish to gain an appreciation of the present status of the transistor and of future trends in this increasingly important field.

A stimulating occasion for workers on many aspects of semiconducting materials to meet and exchange views was provided by an internationally attended conference held at the University of Reading in July 1950. The proceedings of the conference, containing twenty-five papers, have now been published and successfully indicate the scope and direction of research in progress at many of the important centres in Europe and the United States. The electrical and optical properties of semiconductors and photo-effects are the central themes of all the papers; a lengthy paper from the Purdue University group on the effect of nucleon bombardment is particularly welcome, since most of this work has hitherto been published in abstract form only.

In two papers from the Philips' Laboratories the properties of controlled-valency semiconductors are discussed, and the influence of intergranular layers of poor conductivity in polycrystalline materials is illustrated. The work on lead sulphide at the University of Reading and at the Telecommunications Research Establishment is described in four papers, while selenium and semiconducting oxides received consideration from a number of speakers. The remainder deal mainly with the Group IV*b* semiconductors (germanium, silicon and grey tin). The Bell Telephone Laboratories are represented by a paper from Dr. Shockley on carrier injection and one from Dr. Brattain on surface phenomena. The symbols have been standardized throughout the volume and summaries in English and French are provided; the editor must be congratulated on the successful integration of papers from a variety of sources with relatively few errors surviving in the final production. The book will prove invaluable as a reference for several years to come.

R. E. BURGESS

A FIXED-FREQUENCY CYCLOTRON WITH 225-CM. POLE DIAMETER

By HUGO ATTERLING and GUNNAR LINDSTRÖM
Nobel Institute for Physics, Stockholm

At the Nobel Institute for Physics, Stockholm, a large cyclotron—the second at this Institute—was put into operation in 1951[1]. The building of a new cyclotron was decided on as early as in the spring of 1945. After some preliminaries the work on the project was started in the spring of 1946, and during the early work, Mr. Björn Åström was associated with us.

The new machine, which is of the conventional type, that is, operating at a fixed frequency, has been designed to produce deuterons of 25 MeV. energy. For the acceleration of deuterons to this energy in the conventional way, very high 'dee' potentials are necessary (at least 200 kV. across the dees for reasonable beam intensities). As will be shown in more detail in the following, the dimensions of the magnet allow operations at higher energies, either in the conventional way by applying higher voltages to the dees, or by changing the machine to a frequency-modulated cyclotron.

Fig. 1 is a schematic diagram of the cyclotron, including the oscillator circuit. The photograph, Fig. 2, shows the appearance of the machine as seen from the dee stem side.

The magnet, the basic design of which was by Dr. L. Dreyfus of the ASEA Co., which carried out the construction, has a total weight of about 400 tons, the copper windings in the coils weighing 27 tons. The yoke of the magnet is built of 30-mm. thick iron plates which are welded together into heavy beams weighing 20–30 tons each. The coils are wound of 25 mm. × 28 mm. copper bars with a central channel —11 mm. in diameter—for water-cooling.

The poles of the magnet are 225 cm. (88·5 in.) in diameter at the faces. They are extended by the tapered pole tips which are incorporated in the acceleration chamber; the smallest diameter of these tips is 210 cm. The maximum radius for the acceleration is 90 cm. Without the shims which are used for correcting the magnetic field, the total gap between the pole faces is 350 mm., the distance between the pole tips being 330 mm. The latter distance is reduced by about 2 mm. at the central part of the chamber, due to the shims now installed.

The magnetic field necessary for the production of 25-MeV. deuterons is about 11,500 oersteds at the centre; it is obtained with a power input of roughly 60 kW. As, however, the maximum obtainable field is roughly 18,000 oersteds, the machine should be able to produce higher energies if other limitations could be overcome. Because of the difficulty of obtaining higher voltages than 300 kV. across the dees, the deuteron energy must probably be limited to 30 MeV. if the machine is to be used unchanged. A central magnetic field of about 13,000 oersteds corresponds to this energy; a margin therefore remains as far as the field is concerned. This margin will be useful if it should be desired to change the cyclotron to a frequency-modulated machine for producing particles of higher energies.

The quarter-wave concentric dee lines shown in Fig. 1 differ in one essential respect from the lines so far used for conventional cyclotrons. Ordinarily, the dee stems in cyclotrons working with fixed frequency are connected to earth at their ends. In the new Stockholm cyclotron, however, the dee stems are insulated from the earth and connected to the outer conductors by means of condensers, which form a short-circuit for the radio-frequency current. With this arrangement it is possible to apply a D.C. bias voltage to the dees to prevent discharges in the acceleration chamber. The usefulness of a D.C. bias voltage for avoiding such discharges has been demonstrated in frequency-modulated cyclotrons[2]. In cyclotrons of the conventional type, the problem of avoiding the trouble due to discharges in the chamber has not as a rule been approached in this way. The main question in the application of a D.C. bias in the latter case is how to design high-capacity condensers which can be used in high vacuum, and which are able to withstand the very high radio-frequency currents (several thousand amperes) flowing at the nodes of the dee lines. The arrangement designed for the 225-cm. Stockholm cyclotron seems to be a satisfactory solution of the problem involved. This arrangement consists of six water-cooled plate con-

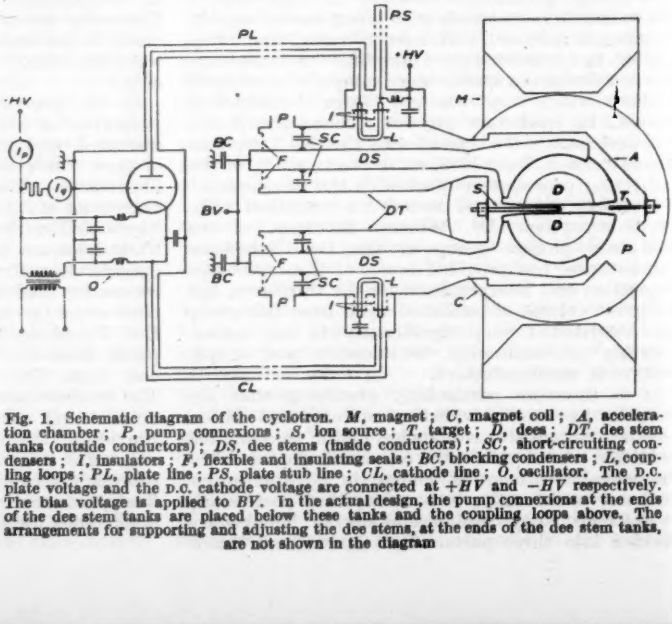


Fig. 1. Schematic diagram of the cyclotron. *M*, magnet; *C*, magnet coil; *A*, acceleration chamber; *P*, pump connexions; *S*, ion source; *T*, target; *D*, dees; *DT*, dee stem tanks (outside conductors); *DS*, dee stems (inside conductors); *SC*, short-circuiting condensers; *I*, insulators; *F*, flexible and insulating seals; *BC*, blocking condensers; *L*, coupling loops; *PL*, plate line; *PS*, plate stub line; *CL*, cathode line; *O*, oscillator. The D.C. plate voltage and the D.C. cathode voltage are connected at $+HV$ and $-HV$ respectively. The bias voltage is applied to *BV*. In the actual design, the pump connexions at the ends of the dee stem tanks are placed below these tanks and the coupling loops above. The arrangements for supporting and adjusting the dee stems, at the ends of the dee stem tanks, are not shown in the diagram

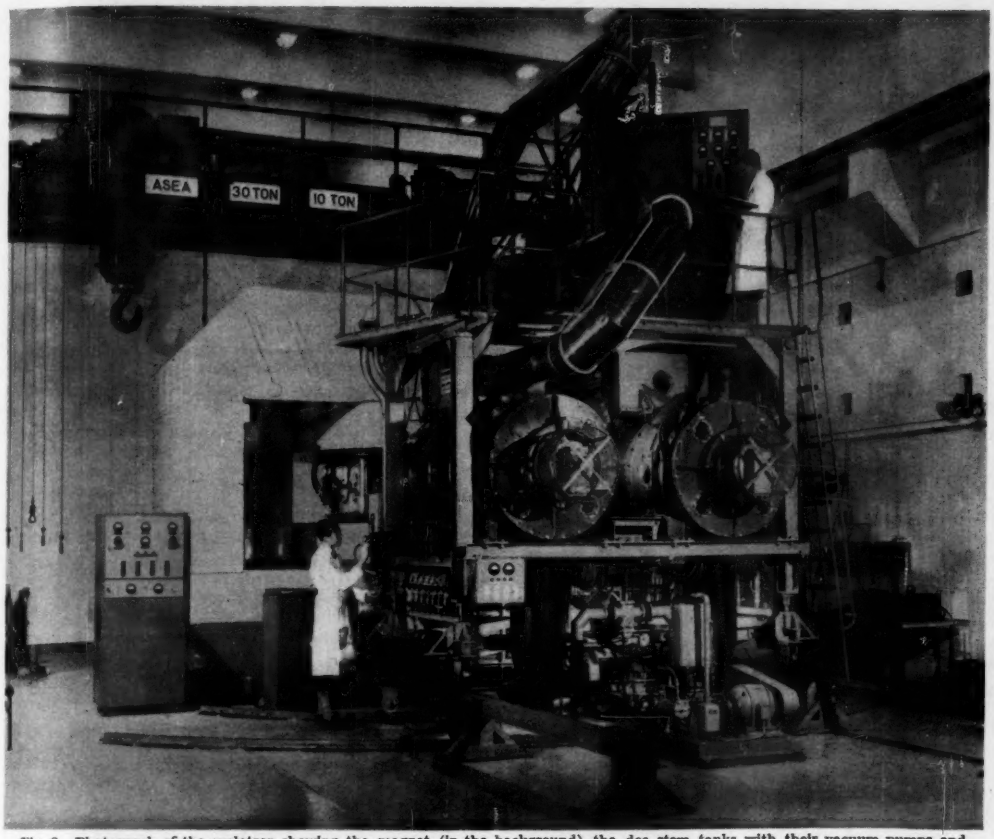


Fig. 2. Photograph of the cyclotron showing the magnet (in the background), the dee stem tanks with their vacuum pumps and the oscillator (on the gallery)

densers around each dee stem, giving about 40,000 micro-microfarads from stem to earth.

The oscillator tube (Standard Telephones and Cables, Ltd., London, Type 4067 *A*) permits a maximum plate dissipation of 160 kW. The high-voltage rectifier for supplying power to the oscillator has a maximum output of 400 kW.

Three large oil-diffusion pumps are used for evacuating the acceleration chamber and the dee stem tanks. Each pump has an unbaffled speed of 4,000 litres per second at a pressure of 10^{-5} mm. mercury. The total volume to be evacuated is about 7,000 litres. When there is no gas flowing in the ion source, a pressure less than 5×10^{-6} mm. mercury can be maintained.

A low-voltage arc ion source with a D.C.-heated filament is used for producing the deuterons. All irradiations hitherto performed in the new cyclotron have been made with an internal probe target.

In order to provide a satisfactory radiation shield between the cyclotron and the surroundings, the machine has been installed in an underground hall with an open water-pond two metres deep on the top of the roof. The cyclotron is operated from a control room in a three-storeyed building above ground, completely separate from the underground hall. When entering the hall it is necessary to descend by lift or stairway to the bottom of a shaft, from which a corridor ten metres long leads to the cyclotron hall.

In addition to the control room, the building above ground houses auxiliary equipment for the cyclotron. It also contains a workshop and several laboratories, among which is a radiochemical laboratory. A pneumatic dispatch system has been installed for sending samples between this laboratory and the cyclotron.

The new cyclotron was first operated in July 1950. At that time, the short-circuiting capacitor at the ends of the dee stems consisted of mica condensers. These condensers made it necessary to keep the dee voltage below 100 kV. (dee to dee) as they broke down at higher voltages. This in turn restricted the acceleration of deuterons to an energy less than that corresponding to the maximum radius (90 cm.). For this reason, the target was inserted to a smaller radius (48 cm.), giving a deuteron energy of only about 6 MeV. The present condenser arrangement was installed in May 1951, and the first acceleration to full radius was performed in the summer of last year. As at that time the oscillator was tuned to a frequency of 7·95 megacycles per second, the corresponding deuteron energy was 21 MeV. A dee voltage of only about 100 kV. was used for these experiments. In the course of the autumn the dee voltage was successively increased to about 200 kV. and currents of more than 100 μamp. of 21-MeV. deuterons were obtained. Later, the frequency was increased to 8·7 megacycles per second in order to obtain the

design energy, 25 MeV. A deuteron beam of this energy was first realized in December 1951.

In all the experiments described above, a negative bias of 500–700 volts applied to the dees proved to be sufficient to avoid discharges in the acceleration chamber.

[1] Atterling, H., and Lindström, G., *Ark. f. Fysik*, **4**, 559 (1952).
[2] Cf., for example, Brobeck, W. M., Lawrence, E. O., MacKenzie, K. R., McMillan, E. M., Serber, R., Sewell, D. C., Simpson, K. M., and Thornton, R. L., *Phys. Rev.*, **71**, 449 (1947).

NEW ZEALAND–AMERICAN FIORDLAND EXPEDITION

By A. L. POOLE

New Zealand Forest Service, Wellington

NOAH could scarcely have been more successful at filling the Ark than were the early acclimatization societies and other organizations at filling New Zealand with wild animals. As a result of these misguided activities, the country has inherited a scourge of introduced wild-animal populations of which there are few prospects yet of even reasonable control. Several of these animals, including the rabbit, goat, wild pig, opossum, red deer, chamois and tahr have become pests over extensive areas[1]. Their great danger lies in the depredations they make on a native vegetation that has evolved almost without the presence of grazing and browsing animals. It is remarkable that hitherto biological studies of these animal-populations have scarcely been attempted, and even the most elementary knowledge of their life-cycles, breeding habits, foods, and spread is lacking.

One of these animals, the wapiti or American elk (*Cervus canadensis*), forming a quite minor population, but one that was thought to be conveniently isolated, ranges over about 100,000 acres in the Fiordland National Park in the very south-west corner of New Zealand. It was recently the subject of a special reconnaissance study. An expedition, conceived by John K. Howard, a hunter and a governor of the Harvard Museum of Comparative Zoology, and sponsored by the New Zealand Department of Internal Affairs, took place for this purpose during the period January–May 1949, and preliminary reports have recently been published*. The wapiti herd, the only naturalized one in the southern hemisphere, originates from eighteen animals procured from Jackson Hole, Wyoming, and liberated in 1905 in George Sound, one of the central sounds of the park. The herd is now estimated by different people at from 500 to 1,000 animals. Dr. O. J. Murie, president of the American Wilderness Society, who lives in Jackson Hole and is a student of wapiti, went out to New Zealand under the Fulbright Scheme to undertake the main part of the study there. A number of parties joined the expedition from time to time, and so made use, for special purposes, of the camping and travelling facilities provided in this little-frequented region.

The Fiordland country inhabited by wapiti is very different from its native range in America. The whole park, consisting of some two and a quarter million acres, has a basic geology of granitic gneisses and diorites which were intensively glaciated in Pleistocene times. The huge glaciated valleys, with sides sometimes sheer for two thousand feet or more, make world-famous scenery. A series of these valleys along the west coast forms the well-known sounds, commencing with Milford in the north and ending with Preservation Inlet, the harbour for Captain Cook's *Endeavour* in 1779, in the south. The divides between the valleys, though seldom more than five thousand feet high, are razor-backed and rugged. Valley steps, moraines and detritus slips across valleys have formed many lakes. The excessive rainfall of two hundred and fifty inches per annum—the highest in temperate climates except for the coastal region of British Columbia—and the comparatively mild climate support a dense vegetation, mainly silver beech (*Nothofagus menziesii*) and southern rata (*Metrosideros umbellata*) with many bog forests up to a height of about three thousand feet, and alpine meadows dominated by grasses above that height. The area inhabited by wapiti is the most rugged part of this country, and is largely unfrequented by man except for tourists along the fringe and for a few hunters. Devoid of agricultural soils or of commercial timber, and possessed of a difficult climate, it has no economic value.

The study of the wapiti proved difficult because of the sheer physical effort required to move about the country and because of the dense forest cover. It was also complicated by the presence of red deer (*Cervus elaphus*) throughout the area and the fact that the two animals are hybridizing. The extent of hybridization is difficult to gauge, for little has been recorded of the variation of red deer in New Zealand or of the changes which the wapiti might have undergone since introduction. New Zealand wapiti are smaller than the average American animal, thus approaching more nearly the size of red deer. This may be partly the result of average age differences. In spite of these complications, Dr. Murie considered that there is enough evidence of hybridization for it to be taken into consideration in any management plan for the herd.

The wapiti have, of course, adjusted themselves to the southern hemisphere seasons and to new foods; but they have found the terrain and climate difficult. Their increase has been slow, and they have also spread slowly. The percentage of calves remaining at the end of a season is low—estimated at 10–15 per cent—and the mortality-rate from accidents must be surprisingly high, if not unique, for a wild-animal population, judging from the number of recorded accidents.

The animals frequent, as winter range mainly, the easier parts of the valley floors, and, as summer range, the alpine forest and scrub and the alpine meadows above the scrub line. The rough valley steps and rocky morainic areas and the steep valley walls remain almost unfrequented. Although certain localities within the populated area are heavily browsed, there is no overall shortage of food, and the country both to the north and the south is as yet not populated at all. In the frequented areas, constant browsing and grazing of preferred shrubs, herbs and ferns has altered the sub-dominant element of the vegetation considerably, though so far it has scarcely affected the regeneration of the dominant beech. Much of the plant cover of this area still remains untouched and is probably the only truly primeval vegetation remaining in New Zealand.

* New Zealand Department of Scientific and Industrial Research. Bulletin 103: Preliminary Reports of the New Zealand–American Fiordland Expedition; Investigations in Fiordland, New Zealand, in 1949. Compiled by A. L. Poole. Pp. 99. (Wellington: Government Printer, 1951.) 7s. 6d.

Some of the persistently browsed plants, such as the fern *Polystichum vestitum*, are related to the food plants of the American wapiti—the comparison here is *Polystichum munitum*; but, by and large, the diet in the two countries is of necessity quite different. One interesting comparison can be made: in their American range wapiti evidently eat much grass and in New Zealand they do the same on the tussock-grass slopes above timber line.

Of other animals introduced into this area opossums (*Trichosurus* spp.) were liberated in the sounds in 1890 and 1893, and no doubt on a number of unrecorded occasions since. The Expedition saw only one of these animals, so it appears that these liberations have not yet spread in numbers. Farther to the north, at Milford Sound, opossums are well established.

Certain animals have immigrated into the area. In the 1880's, rats (*Rattus rattus* and *R. norvegicus*) were stated to be present in the sounds in great numbers, but they suddenly disappeared about 1902—a disappearance which seems to have coincided with the appearance of stoats. The immigrations of these two animals are recorded as having had marked effects on the numbers of certain species of birds. Members of the Expedition trapped no rats, but they did trap stoats—in poor condition—which were also observed occasionally throughout the area, mainly along waterways. Since no rats or mice are present, the stoats must live on birds.

Once the stronghold of the kakapo (*Strigops habroptilus*), this bird has almost disappeared from the area; only two were recorded during the Expedition. A similar reduction in the numbers of other native birds seems also to have occurred; for example, the grey teal (*Querquedula gibberifrans*), native thrush (*Turnagra capensis*), and robin (*Miro australis*). Native pigeons (*Hemiphaga novæ zealandiæ*), wekas (*Gallirallus australis*) and bell birds (*Anthornis melanura*), on the other hand, were found to be plentiful, and the mountain-tops above always had their population of keas (*Nestor notabilis*), a parrot that has the flight of an eagle and in some high country in New Zealand is responsible for the killing of a few lambs. Four introduced birds were recorded for the first time, namely, the mallard duck, chaffinch, redpoll and hedge sparrow.

Insect life was not plentiful, though, as was expected, a number of new species were collected. It will be some time before collections are worked over by specialists. To date, of twelve species of *Opiliones* collected, only one has been previously recorded; about twenty new species of spiders, including two in the rare family Archæidæ, are in the collections. Entomologists considered that some groups of insects are represented in the Fiordland area by relict species of considerable antiquity. Although mosquitoes are a scourge on parts of this coast, only two or three were recorded during the whole course of the Expedition. Sandflies (*Austrosimulium ungulatum*), however, abounded and necessitated, at lower elevations, the constant use of dimethyl phthallate repellent. A special search for their breeding-places met with no success.

A general study of the vegetation of the area was made—apart from the special study of the effects of deer feeding—for hitherto spasmodic collecting only has been carried out in any part of the Fiordlands. The flora contains some three hundred species of flowering plants and ferns, including a few new species belonging mostly to notoriously variable New Zealand genera, such as *Carmichælia* (Leguminoseæ), *Celmisia* (Compositæ), *Anisotome* (Umbelliferæ), etc.

A party of forest surveyors maintained that the forests are undergoing a comparatively rapid change following recent climatic changes. This was adduced from the evidence of a markedly broken and receding timber-line in the west, and sparsity of regeneration of forest species, more common farther north, now only present in confined areas in the Fiordlands. Such a finding is in keeping with much evidence of comparatively rapid forest migration accumulated by the National Forest Survey for forests farther to the east. The Soil Survey has produced, from soil data, evidence of similar changes, and palynologists show the same trend in vegetation changes from their pollen profiles.

A party of surveyors made use of the Expedition's facilities to carry out a major triangulation of part of the area. On this triangulation contours were inserted from aerial photographs. Such data are required for possible hydro-electric development schemes. The climate is such that, during five months field-work, there were only seventeen days on which the party could use a theodolite on the mountain-tops.

[1] Wodzicki, K. A., "Introduced Mammals of New Zealand" (Wellington, N.Z., 1950).

THE MARKING OF WHALES

By Dr. N. A. MACKINTOSH, C.B.E.
National Institute of Oceanography

THE research on whales developed under the Discovery Committee and continued under the National Institute of Oceanography is in many ways comparable to fisheries research. It is principally, though not exclusively, concerned with those aspects of the biology of whales which have a direct or indirect bearing on whaling, and attention has been directed mainly to their distribution, migrations and movements; their breeding, growth and age; their feeding and other habits; the constitution of the populations; and the oceanographical background to these more direct studies. The results are made available to the Ministry of Agriculture and Fisheries and to the International Whaling Commission, which is the body responsible for the international regulation of whaling and conservation of the stock. Work in some other countries also is carried out to some extent on similar lines.

Much new information has accrued, especially on the life-cycle of whales, from the examination of the carcasses at land stations and in factory ships; the ocean environment of the main concentrations of whales has been surveyed by the R.R.S. *Discovery II* (and earlier by the *Discovery I*); and the records of the whaling industry are an essential source of information. New plans also are being made for gathering material from various whaling centres, and (with the ready co-operation of the Meteorological Office) for the collection of observations on whales from merchant and other vessels; and certain new anatomical investigations have begun. There are peculiar difficulties, however, in the study of living whales and their collective habits, for they are remote and elusive animals. The catches of the whalers (since they are biased to some extent by selection, and by the weather, the regulations, and economic factors) are not accurately representative of the

population ; and the study, for example, of the breeding cycle must be limited or uncertain so long as it depends only on the circumstantial evidence furnished by examination of the reproductive organs.

For most aspects of the work the best evidence is provided by the marking of whales. The mark used is a tube of stainless steel which is fired from a 12-bore shot-gun. It is engraved with a serial number and a notice of a reward for its return. Forms are distributed on which the whaling companies are requested to give such particulars as the date, place of capture, species, sex, length, etc., of any whale from which a mark is recovered.

The essential advantage of marking is that each mark identifies a living whale, and each mark recovered provides one or more significant facts which could not otherwise be ascertained ; for example, a whale has moved from point *A* to point *B* in a known period, and the whale has lived from one date to another. Even a few recoveries tell a story ; but the greatest value of marking depends on the accumulation and upkeep of a body of data sufficient for statistical treatment. It is not a method which can alone solve all problems, but it gives direct evidence on the distribution and movements of whales, on populations, and on the effects of whaling ; and taken with other data, the recovered marks can throw light on almost any aspects of the natural history of whales which are connected with time, place and movement, including the various stages of breeding, growth and age.

The principal large whales of economic importance are the blue, fin, humpback and sperm. Nearly all the marking has been done by the R.R.S. *William Scoresby* and hired whale catchers, and before the War—between 1932 and 1938—about 5,350 whales were marked, more than half of them fin whales. Of this total more than 99 per cent were marked in the Antarctic. In 1950, in the course of a voyage devoted to both marking and oceanographical work, the *William Scoresby* marked 79 whales, mostly sperm, in African waters. Some have also been marked by organizations in other countries in co-operation with the Discovery Committee, and some separate marking has been done by the Japanese in the North Pacific. Special importance is attached to the marking in African waters, because so little had been done hitherto outside the Antarctic ; but the fact remains that the numbers of whales marked since 1938 are relatively insignificant.

The total number of marks recovered so far is 300, of which 47 are from blue, 213 from fin and 40 from humpback whales. This is about 5½ per cent of the whales marked ; but it must be remembered that an unknown number may drop out of the whales, and others may be overlooked or not sent in, so that the real percentage of marked whales killed may be much higher. Pre-war marks are still being recovered, but the number diminishes each year and only six were received from the Antarctic whaling season of 1950–1. Details of the principal results obtained after the first few years have been given by Rayner[1] and some later results by Mackintosh[2]. These may be summarized as follows. (The more recent data will be examined when more marks have accumulated.)

(1) Marking has afforded direct proof that long-range seasonal migrations take place between the Antarctic and the tropics. Formerly there was only indirect evidence for this.

(2) Marks recovered between one and fifteen years after firing show that blue and fin whales generally tend to revisit the same part of the Antarctic year after year after the winter migration. One implication of this is that any depletion of the stock tends at first to have a local effect : the population will not be quickly replaced from other areas.

(3) Humpbacks keep even more rigidly to their own territory. Recovered marks, together with observations at sea and the positions of capture by the factory ships, indicate that there are several separate groups in the Antarctic, each of which has a separate migration route to one of the coastal regions of the southern continents. No humpback marked in one group has been recovered from another group. The best-known migration is that between north-western Australia and an Antarctic region to the south-west between 80° and 100° E. It seems likely that there are five distinct populations, but some details of the picture are still uncertain.

(4) Marking has furnished some information, and could provide much more, on the local movements of whales during the Antarctic summer.

(5) The percentage of marks recovered from the different species over a period before the War was highest in humpbacks, second in blue and third in fin. This strongly suggested that the severity of taxation of the stocks of the three species was in that order.

(6) The proportions in which the species have been marked, or counted in the course of marking, have assisted a rough estimation that the ratio of blue, fin and humpback whales in the Antarctic before the War was of the order of 15, 75 and 10 per cent respectively. Many details of their habits and distribution have also been observed during marking.

(7) Evidence is beginning to accumulate on the age and growth of whales. Some marks have been carried in whales for periods up to fifteen years.

It need scarcely be emphasized that the results obtained so far are only the beginning of what might be revealed by marking, and much more information is urgently needed. Whaling has become an important industry, and the annual value of the oil alone which is produced in the Antarctic probably amounts now to between £30 and £40 million ; yet all too little is known about whales, and without renewed marking on a large scale it will be hard to make substantial progress in research. A whale-catcher or similar ship is required, and although the cost is not high in relation to the value of the results, it is at present the main obstacle to further activity. The National Institute of Oceanography must give priority to the basic needs of general oceanographical research, and with the present financial stringency cannot recommission the *William Scoresby* or charter a catcher. It is hoped, however, that some means will be found of continuing the work. The following are some of the more evident requirements.

First, there is the simple need for marking a large number of whales, and it is in the Antarctic that the largest numbers of whales can be found. The 300 marks recovered so far are much too few for generalizations on an adequate statistical basis, and it cannot be expected that many more of the pre-War marks will be returned. Recoveries from whales newly marked in the Antarctic, however, could give much-needed new information on migrations and wanderings, and such questions as the interchange between populations and the composition and stability of schools and herds. Changes in local distribution during the summer might go far to clarify the reactions of whales to the oceanographical conditions. There is

hope that the ratio of recovered marks may help to solve the great problem of the actual numbers of whales in the populations. If marking can be continued from year to year, some of the effects of whaling and of the measures taken by the International Whaling Commission might be observed in such phenomena as changes in the ratio of marked whales which are killed, and changes of distribution or trends of movement; but for reliable evidence on such matters the work would have to be carried out on a scale sufficient to maintain a large number of returns. Marking is needed also in parts of the Antarctic where no whales have yet been marked; for example, on the whaling grounds south of Australia and New Zealand, and in the western part of a sanctuary which has been established in the Pacific sector.

Secondly, whales need to be marked during their winter residence in warmer waters, especially where breeding takes place. The migrations of humpbacks in the southern hemisphere are understood in broad outline, but many points still need clarification. More valuable work, however, could be done if the main winter habitat of blue and fin whales can be located—and the observations from merchant vessels, referred to above, may be of assistance here—for almost nothing is known of the range and direction of their migrations. One of the most urgent needs of all is to mark young whales and breeding whales. If some marks can be recovered (with adequate particulars) after short and longer periods from whales which, at the time of marking, were young calves or were in observed stages in the breeding cycle, a great stimulus would be given to nearly all investigations on the breeding, growth and age of whales. There are practical difficulties here, but they are not insurmountable. In any event, it is hoped that the collection of certain anatomical material from marked whales will lead to improvements in the rather limited methods available so far for the determination of age.

Thirdly, there is a special need for marking sperm whales, since so little is known about this species. The breeding herds in tropical and subtropical regions need attention, and not much less important are the adult males which frequent the colder seas.

There is always an element of luck in hunting for whales, whether to kill or to mark them, and it cannot be expected that all these problems will be solved. On the other hand, it is almost certain that the analysis of a larger body of records will suggest new ideas and bring to light unexpected facts. Such results, indeed, are sometimes of greater value than those which can be aimed at in advance.

[1] Rayner, G. W., "Discovery Rep.", **19**, 245 (1940).
[2] Mackintosh, N. A., "Discovery Rep.", **22**, 236 (1942).

EARTH TIDES

IT is, probably, not generally realized that the position, with respect to axes fixed in the earth, of an apparently fixed point on its surface, varies diurnally. Yet in some places the land surface may move up and down by as much as ± 9 in. A study of the distortion of the earth's land surface by the tidal potentials of the sun and moon yields evidence, more conclusive than that from seismology, that its central core is liquid. Moreover, the diurnal variation of gravity, which is a consequence of this distortion, is of great practical interest to prospecting geophysicists. Their modern instruments will easily detect the effect and are incapable of being used to the full advantage of their accuracy unless a means is found of correcting for it. The investigation of earth tides thus forms a meeting-ground both for theoretical and practical geophysicists. Both were represented at a Geophysical Discussion on the subject, held in the rooms of the Royal Astronomical Society in London on November 23. Dr. B. Baars, of the Royal Dutch Shell Oil Co., came specially from Holland to give an account of the world-wide programme of measurements inaugurated by his Company. Prof. H. Jeffreys gave an account of the recent theoretical work on the subject carried out both by Takeuchi in Japan, and by himself. Dr. R. H. Corkan, of the Liverpool Tidal Institute, and Prof. R. Tomaschek, of the Anglo-Iranian Oil Co., also spoke. Mr. B. C. Browne, of the Department of Geodesy and Geophysics, Cambridge, was in the chair.

Dr. Baars gave an account of the results of the gravity observations, inaugurated by the Shell Company, for the determination of tidal variations of gravity. The amplitude of the diurnal variation of gravity is about ± 0·15 mgal., and modern gravity meters can read gravity to ± 0·01 mgal. During a gravity survey, returns to the base-station in order to correct for instrumental drift are necessary. The change in reading found represents the combined effect of drift and the diurnal variation. The practical purpose of the investigations was to determine the latter, so that less-frequent returns to the base station would be necessary and greater accuracy would be attainable than if it remained unknown.

A series of measurements at twenty-six stations was made, three of them provided with two instruments. Fifteen of the stations were sponsored by the Shell Company and eleven by other interested companies and universities, which co-operated voluntarily. Gravity measurements were made every quarter of an hour by a team of three observers working 9-hr. overlapping shifts at each station. Corrections were applied to the results to take account of the personal equation of the observers and its dependence on fatigue. Corrections were also applied for jumps in the reading of any instrument, although few of these could be explained, and for the small steady drift of each instrument. Since the drifts were not monotonic, running averages were taken over 24 hr. to eliminate the tidal periods. These are not exactly 12 hr. and 24 hr., but the difference does not cause appreciable error.

The theoretical variation of the value of gravity on a rigid earth was computed from nomograms, and the results from each instrument were expressed as the ratio of the observed variation to this theoretical variation. (The term 'rigid' here means that the modulus of rigidity is infinite; 'elastic' means that it is finite.) The average value of this ratio for each instrument was calculated from a mean of the ratio weighted according to amplitude. Some stations had to be discarded because of unexplained effects. For example, one station showed a strong diurnal term which was suspected to be due to temperature changes in the instrument. The mean of all the results gives a value for $1 + h - \frac{3}{2}k = 1{\cdot}22$ (for explanation of symbols see later), with a scatter between 1·09 and 1·39. The double stations also show a scatter (Sorong I and II, 1·24 and 1·29; Edmonton I and II, 1·10 and 1·22; Houston I and II, 1·18 and 1·19). There appears to be very little

phase lag between theoretical and observed variations.

In conclusion, Dr. Baars said that the results fit calculations for a model earth which have been made by Takeuchi[1], though there is a slight indication that the surface density of 3·0 gm. c.c.$^{-1}$ assumed by him may be too high. Present data are, however, insufficient to decide the question. He was uncertain whether the variations in $1 + h - \frac{3}{2}k$ at different sites represent a real variation or not, and he had found no correlation of the values with the site of the station. For example, the values were apparently not related to distance from the sea coast.

Prof. H. Jeffreys pointed out that the observable quantities in the theory of earth tides are related to three numbers h, k, l, of which the first two were introduced by Love and the third by T. Shida. If the gravitational potential due to an external field is W_2, a solid harmonic of degree 2, and the earth yields elastically, the vertical displacement at the surface is hW_2/g; the disturbance of the external field at the surface is kW_2; and the horizontal displacement at the surface in any direction is al/g times the gradient of W_2 in that direction, a being the earth's radius.

In a body of water, the bed and the free surface show different vertical displacements, and the tidal effect on the depth is proportional to $1 + k - h$. In the free (14-monthly) variation of latitude the changes of the axis of rotation act similarly to an extra gravitation potential, and the period effectively determines k. The tidal variation of gravity is proportional to $1 + h - \frac{3}{2}k$. In astronomy, the earth is usually treated as a rigid body, so that the vertical indicated by a mercury trough is considered as fixed relative to the earth. But tidal forces displace the vertical and also alter the form of the earth itself, and consequently there are systematic tidal effects on astronomical observations. The ratio of these for an elastic earth in comparison with a rigid earth is $1 + k - l$. There are, accordingly, essentially four observable factors, each of which should be the same for all tidal components.

Until fairly recently, observations of k and $1 + k - h$ have been used to give estimates of the earth's mean rigidity. The rigidity has now been found in much more detail from seismology and the argument can be reversed; all the four ratios can be calculated by elasticity theory and compared with observation. The problem is formidable because it is necessary to solve three simultaneous second-order differential equations, with coefficients given by numerical tables. Takeuchi's solution[1] is as follows:

	Calc.	Obs.
k	0·281–0·290	0·27–0·29
$1 + k - h$	0·67–0·70	0·66–0·70
$1 + h - \frac{3}{2}k$	1·15–1·19	1·22
$1 + k - l$	1·20–1·22	1·22

As the comparison affords a crucial test of the fluidity of the core, it is of interest that Takeuchi has also worked out the greatest possible rigidity of the core that is compatible with the tidal data, and it is about 10^9–10^{10} dynes/cm.^{2}. The bulk modulus is of order 10^{12} dynes/cm.^{2}, so that the fluidity can be regarded as confirmed.

Prof. Jeffreys then remarked on a further complication. He said that it had always been supposed in tidal theory that the inertia associated with elastic displacements could be neglected, so that a statical theory could be used. This was justified, on the ground that the slowest elastic vibration would have a period of about 40 min. and the fastest tidal period is about 12 hr. But when the theory was extended to a liquid core, the rigidity was simply neglected and the legitimacy of still neglecting inertia was not examined. Bondi and Lyttleton directed attention to this point. It turned out that the neglect was justified for tidal components that did not alter the direction of the axis of greatest moment of inertia, and therefore for the semidiurnal, fortnightly and semi-annual tides; thus most of Takeuchi's comparisons would stand. But appreciable corrections would be needed for other tidal components, namely, for the diurnal group and the variation of latitude.

With a rigid shell, Prof. Jeffreys found that a fluid core would shorten the theoretical free period from 305 to 270 days. The 19-yearly nutation arises from the same tidal force as that producing the diurnal tide known as the lunar K_1. For this there is a known discrepancy, first pointed out by J. Jackson. The theoretical amplitude given by Spencer Jones (for a completely rigid earth) is $9{\cdot}227'' \pm 0{\cdot}001''$, and the observed amplitude about $9{\cdot}207'' \pm 0{\cdot}003''$. Allowance for a fluid core would diminish the theoretical amplitude, but by about three times as much as is required to bring the results into agreement.

The next step was to try a uniform elastic shell. A mean rigidity was found that would bring the free period into agreement with observation, and was seismologically plausible, but still left the effect on the nutation too large. Then Takeuchi's solution became available, and his theory for the shell was combined with that for a homogeneous liquid core. The result is that the theoretical free period now becomes about 460 days against the observed 440 days. The effect on the nutation has been reduced slightly, but still remains a little too large. It will be necessary next to allow for differences of density within the core; this will be a difficult problem.

Dr. R. H. Corkan described the results of tilt observations taken during the past forty years at Bidston in north Cheshire. The first attempt to show tidal tilt was made by Prof. J. Milne at Shide in the Isle of Wight. His measurements appeared to show that the coast was raised at the time of high water in the Solent. The first reliable measurements were made at Bidston by Plummer in 1909 and were communicated to the British Association in 1910. These showed that the crust is locally depressed by the tidal loading at high water. Analysis of the observations showed that the semidiurnal constituents in the tilt were in agreement with those in the tide but that the diurnal constituents were in opposite phase.

In 1933 Dr. A. T. Doodson and Dr. Corkan commenced work on the problem of distinguishing the loading effect from the true earth tide by harmonic analysis. The anomalous result for the diurnal tilt was shown to be explained by the existence of the diurnal earth tide, though at first there appeared to be evidence that the diurnal earth tide does not follow the equilibrium law. When observations had been taken for a complete year, it was found that there are large variations in the diurnal constants from month to month. These are very hard to explain and no definite conclusions can be reached. The K_1 constants (luni-solar diurnal) might be expected to be affected by thermal effects, but no such explanation can be applied to the O_1 constants (lunar diurnal). At Bidston the diurnal tilt is small because the tilts

from loading and from the earth tide are of opposite phase.

No similar difficulty was experienced with the semi-diurnal tilt, and the semi-diurnal loading effect was separated from the earth tide by combining the tilt constants for the three principal constituents M_2, S_2 and N_2 (principal lunar, principal solar and larger lunar elliptic, respectively). The method was such that for a single station the phase lag of the earth tide had to be assumed and it was satisfactory to assume this lag to be near zero. Recently it was realized that, if observations of tilt are available for at least two stations, where the inter-relations between the tilts from loading and the earth tide are different, then the lag of the earth tide as well as all other unknowns may be determined for both places. Search was made for a suitable place, and the data of Egedal and Felstadt obtained at Bergen in 1934, from observations of levels in a long water-filled pipe, have now been combined with observations taken at Bidston during 1934–36.

Dr. Corkan went on to describe how the Bidston data have been treated. In what follows, *BT* refers to the true tilt of the figure relative to an earth yielding elastically without the secondary effects of the water tides; *ET* refers to the true tilt of the figure relative to a rigid earth; *LT* refers to the extra tilt produced by the water tides relative to an earth yielding elastically, whether in the form of a tilting of the crustal layers or a distortion of the gravitational field; *BT*/*ET* is therefore the quantity $(1 + k - h)$; what is measured is $LT + BT$.

The following assumptions were made: the ratios of amplitudes of the same components in *BT* and *ET* are the same, the ratios of amplitudes of the same components in *LT* and the loading tide are the same, the phase lags of all semi-diurnal components in *BT* are the same. It is important to note that the ratios of amplitudes in the loading tides are easily inferred since they change slowly from place to place; they are also fairly consistent in many of the seas of the world.

The phase lags of the loading tilt were not inferred from the loading tide but were determined from the reductions. To combine the results at Bidston and Bergen, it was necessary to assume that the earth tide at both places is the same, allowing for latitude variations, and that the earth tide does not depend on the direction in which it is measured. The results which fitted Bergen and Bidston best were consistent with a lag of 8° in the semi-diurnal components of *BT*, and a value of 0·65 for $1 + k - h$.

In conclusion, Dr. Corkan produced a table showing the ratios of amplitudes of M_2/S_2 and M_2/N_2 in the seas of the world. The ratios in the neighbouring seas and the average ratios for the world are in general agreement with those used in the reductions. It would thus seem, since no inferences were made from the phase lags of the water tides, that the method allows automatically to a very large extent for the secondary effects of the tides all over the world.

Owing to an abnormally small value of S_2 in the western Atlantic, this would not be true if the method were applied to the earth tides recently observed near Washington in the David Taylor Model Basin. Thus the method is not generally applicable.

Prof. R. Tomaschek described his investigations on deviations of the vertical in the salt mine at Winsford in north Cheshire, which have been made with horizontal pendulums of the Zöllner type since March 1949. He displayed some of the results, both in the form of graphs of the variation, with time, of the north–south and east–west components, and in the form of polar diagrams, showing the locus of the end-point of the tilt vector as a function of time.

The polar diagram shows immediately the influence of the load tilt due to the sea tides in the Irish Sea, which is predominant, as high water occurs there nearly everywhere at the same time. For certain times the observed tilt in the westerly direction varies very little, showing that the earth tilt and the load tilt nearly compensate each other over these periods at this distance from the sea.

Another interesting result is an annual variation in the seasonal tilt, with a maximum to the south in summer (a tilt to the south means that a horizontal pendulum bob is deflected in this direction). The seasonal tilt also varies more smoothly in summer and is nearly constant from June to September. It begins fairly suddenly to become quite disturbed at the end of October, followed by erratic tilting throughout the winter and in spring. The amplitude of the seasonal tilt is of the order of several seconds.

The results of harmonic analysis were shown in vector diagrams. During the disturbed period the diurnal terms, especially K_1, show strong disturbances, which are due to a fairly pure sinusoidal oscillation of diurnal period (S_1), which repeats itself very nearly during March 1951 and 1952.

Assuming that $1 - h + k = 0{\cdot}72$, the body tilt was determined. The influence of the maritime tides was also determined, and from this, according to the formulæ given by Darwin and Boussinesq, the elastic constant of the upper strata was derived.

The former observations from four Continental stations (Marburg, Pillnitz, Beuthen and Berchtesgaden) have been evaluated for residual tilts. Compared with the results at Winsford, it is found that they can be interpreted as due to a general elastic yielding of the same elasticity as found at Winsford and a superposition of tilting of tectonic blocs. The influence of the Alps is seen in a predominance of a north–south tilt. The results show clearly, furthermore, the effect of the tilting of the Russian shield at the easterly stations, the Variscan structure in the middle stations and the Caledonian bloc at the westerly station Winsford.

Tilts due to barometric changes have been noticed in special cases. A characteristic example including the general meteorological situation was displayed. The seasonal disturbances are not connected with any marked change in the meteorological conditions at the point of observation. There seems to be a more general connexion with the regional conditions.

Prof. Tomaschek concluded by showing that there exist strong correlations of the seasonal tilt with other phenomena which might be associated with an annual variation in the stresses in the crust, such as the variation in the length of the day, the frequency of shallow earthquakes or the flow of oil-wells in the Eakring area. He also referred briefly to the gravity measurements which were made by the Anglo-Iranian Oil Co. at two places in the United Kingdom in connexion with the Shell Company's programme. They gave the general values of $1 + h - \frac{3}{2}k = 1{\cdot}10$ and 1·00. He said that for calculations of the yielding of the earth the values of $1 + h - \frac{3}{2}k$ obtained by harmonic analysis were preferable. The mean of these values, belonging to the least disturbed M_2 term,

gave 1·18, which is in better agreement with Takeuchi's value.

The considerable interest aroused by Prof. Tomaschek's work stimulated the following additional remarks. The adjustment in the surface crust at the end of October seems, from all accounts, to be fairly sudden. On October 27, 1872, d'Abbadie reported a sudden large change in the vertical measured with a mercury trough level. On October 22, 1951, Dr. Corkan observed a sudden tilt at Bidston, as at Winsford, and there was also a sudden tilt in the Po Valley in north Italy. The interpretation of the tilting at the Continental stations is unlikely to be affected by shallow faults. (The Boussinesq solution for the tilting of an elastic plate shows that a fault would have to extend to a depth of about one-third the diameter of the Continent in order to have appreciable effect.) Winsford is embedded in a sedimentary trough some 6,000 ft. deep, between the Pennines and the Caledonian axis. All possibilities of correlating other phenomena with the annual variation of tilt are being investigated; for example, magnetic effects. No similar observations in the southern hemisphere appear to have been made, but it is possible that the effects might well be smaller on account of the more even meteorological conditions prevailing there.

[1] Takeuchi, H., *Trans. Amer. Geophys. Union*, **31**, 651 (1950).

OBITUARIES

Dr. W. J. Elford, F.R.S.

Workers in many fields of science will regret the untimely death on February 14 of William Joseph Elford. He came of a family long associated with Malmesbury in Wiltshire, where he was born in 1900. He graduated in 1923 from the University of Bristol, and afterwards held a Colston Research Fellowship, working under Prof. J. W. McBain.

In 1925 he joined the staff of the National Institute for Medical Research and remained for the rest of his working life. When he arrived, a big programme of work on virus diseases had been instituted there, and a wide field was open for the study of the physico-chemical properties of viruses. Building on the earlier work of Bechhold, Elford found out how to prepare a series of graded collodion ('Gradocol') membranes, having pores of very uniform size. With these he worked out methods of ultrafiltration analysis for particles within the size-range from protein molecules to bacteria. With numerous collaborators he determined the sizes of many viruses including bacteriophages. Knowledge so obtained is at the basis of much we know about viruses to-day. Subsequent work, making use of other techniques, has to a remarkable extent confirmed the estimations of virus sizes which Elford made from his studies on ultrafiltration. He himself contributed further by his inverted capillary tube method in centrifugation analysis and by his studies of the density of virus particles.

Elford made a number of contributions to knowledge about bacteriophages, and, during the Second World War, to aerial disinfection. Among other things he showed that ozone was of no practical value for sterilizing air under conditions tolerable to human beings.

Recently, with other colleagues, he made a most useful contribution to the technique of electron-microscopy by showing that certain viruses which are adsorbed to red blood cells are equally well adsorbed to the stomata of red cell 'ghosts'. These form very suitable images for study by the electron-microscope, and the attachment of influenza and other viruses to them can be directly observed. In 1949 he unexpectedly found that recently isolated strains of influenza virus existed largely in the form of long filaments, and it seemed possible that the previously recognized spherical forms might develop within these or as a result of their fragmentation—a novel concept of virus-multiplication.

Elford, who remained a bachelor, was devoted to his laboratory work, in which he was scrupulously painstaking. He was an ideal, always willing, collaborator, working excellently with many biological colleagues. He quickly assimilated the biologists' point of view and, in turn, taught them the advantages of exact quantitative methods. He was elected a Fellow of the Royal Society in 1950. For nine years his health had not been good; but he continued working until the onset of his brief final illness. His place will be very hard to fill.

C. H. Andrewes

Dr. H. W. Dickinson

The death of Dr. Henry Winram Dickinson, which occurred at Purley, Surrey, on February 21, will be regretted by students of technological history in many lands, for not only did he do outstanding work at the Science Museum, South Kensington, but also he was the most active member of the Newcomen Society for furthering the study of the history of engineering and technology from its formation in 1920. The parent Society has now a membership of more than four hundred, while "American Newcomen", as the autonomous North American branch is often referred to, has a membership of more than 12,000. The birth of this branch was due to Dickinson's visits to the United States, during one of which he was given the honorary degree of D.Eng. by Lehigh University.

Born at Ulverston, Lancashire, on August 28, 1870, Dickinson attended Manchester Grammar School and Owens College, and was trained as an engineer in Glasgow. In 1895 he joined the staff of the Science Museum, and during the next thirty-five years served under four directors—General E. R. Festing, W. I. Last, Sir Francis Ogilvie and Sir Henry Lyons. He became the senior keeper, having charge of the Engineering Division, and was secretary to the Advisory Council. His position in the Museum brought him into contact with engineers from all parts of the world, and he counted among his friends Dr. Oscar von Miller, the creator of the Deutsches Museum at Munich, at the opening of which he was the British representative. He retired from the Museum in 1930, but his interest in its fortunes never flagged.

The formation of the Newcomen Society in 1920 had given Dickinson further scope for his business abilities, his love of research and his flair for writing; and in the companionship of its members he found his greatest joy. He wrote many articles, addresses, memoirs and books, among which were those on Fulton, Wilkinson, Watt, Boulton and Trevithick. From the first he edited the Society's admirable *Transactions* and was always to the fore in its

summer pilgrimages to various centres and at centenary commemorations of notable engineers and inventors. He was president of the Society during 1932–34 and last year was made secretary emeritus after serving as honorary secretary for thirty-one years. He acted as honorary secretary of the Second Congress on the History of Science and Technology, held in London in 1931, and as a section chairman at the Sixth Congress held in Amsterdam in 1949. Of robust constitution, he retained his vigour until his eighty-first year and few have led a more active career. EDGAR C. SMITH

NEWS and VIEWS

International Committee on Bacteriological Nomenclature: Prof. T. Wikén

PROF. TORSTEN WIKÉN has recently been appointed joint permanent secretary of the International Committee on Bacteriological Nomenclature in succession to Dr. R. S. Breed, who has been secretary for non-medical bacteriology since the Committee was set up in 1930. Prof. Wikén was born in Soderhamm, Sweden, in 1912, and studied botany, chemistry and zoology at the University of Uppsala. He has worked at the Institute of Technology, Delft, with Prof. A. J. Kluyver, at Iowa State College with Prof. C. H. Werkman, and at Berkeley, California, with Prof. H. A. Barker. He is now professor of agricultural bacteriology and fermentation at the Swiss Federal Institute of Technology, Zurich. In the fields of nomenclature and taxonomy, Prof. Wikén is particularly interested in the *Clostridia* and the yeasts; but his research work has included a study of the methane bacteria, microbiological assay of vitamins, production of antibiotics by fungi, and the use of radioactive and heavy carbon in fermentations. Prof. Wikén's address is: Institut für landw. Bakteriologie und Gärungsbiologie, Eidg. Techn. Hochschule, Universitätstrasse 2, Zurich 6.

Royal Society of Edinburgh: New Fellows

THE following have been elected to the Royal Society of Edinburgh: Prof. M. L. Anderson, professor of forestry, University of Edinburgh; Dr. E. R. Andrew, lecturer in natural philosophy, University of St. Andrews; Dr. L. Auber, senior scientific officer, Department of Biology, Wool Industries Research Association, Leeds; Sir Henry Beresford-Peirse, director in Scotland of the Forestry Commission; Prof. H. G. Callan, professor of natural history, University of St. Andrews; Dr. Mary Collins, senior lecturer in psychology, University of Edinburgh; Mr. J. Dainty, senior lecturer in medical physics, University of Edinburgh; Prof. R. W. B. Ellis, professor of child life and health, University of Edinburgh; Dr. R. C. Fisher, officer in charge of the Section of Entomology, Forest Products Research Laboratory, Princes Risborough; Mr. W. R. Flett, senior lecturer in geology, Royal Technical College, Glasgow; Prof. K. V. Krishnan, professor of microbiology, All-India Institute of Hygiene and Public Health, Calcutta; Mr. D. MacDougall, chief chemist, Fuel Research Station, Greenwich; Prof. H. Nicol, professor of agricultural chemistry, West of Scotland Agricultural College, Glasgow; Dr. (Mrs.) Ethel E. Percival, lecturer in chemistry, University of Edinburgh; Mr. M. H. Quenouille, lecturer in statistics, University of Aberdeen; Mr. J. Reed, consultant engineer, Edinburgh; Dr. A. Ritchie, principal scientific officer, Marine Laboratory, Aberdeen; Dr. J. D. Robertson, lecturer in zoology, University of Glasgow; Emeritus Prof. S. J. Shand, formerly professor of geology, Columbia University; Dr. T. B. Simpson, Sheriff of Caithness, Sutherland, Orkney and Zetland; Dr. H. D. Slack, senior lecturer in zoology, University of Glasgow; Dr. J. A. B. Smith, director of the Hannah Dairy Research Institute, Ayr; Dr. D. ter Haar, lecturer in theoretical physics, University of St. Andrews; Prof. I. M. Thompson, professor of anatomy, University of Manitoba; Mr. A. R. Wannop, technical development officer, Department of Agriculture for Scotland.

Geophysical Research Institution of the University of Copenhagen

IN order to promote geophysical research at the University of Copenhagen, a private and independent institution has been created with Dr. Niels Arley as director. It will be known as the Geophysical Research Institution, University of Copenhagen, and its address is c/o Institute for Theoretical Physics, Blegdamsvej 15, Copenhagen Ø. The governing board consists of Prof. H. M. Hansen, rector of the University, Prof. Niels Bohr and Dr. Arley. Two scientific assistants have been appointed: J. Espersen and P. Andreasen. The provisional programme of the Institution is threefold: to continue on future deep-sea expeditions the work of measuring the geomagnetic field in the oceans as a function of position, depth, form and physico-geological nature of the bottom, and time (secular variation); to investigate the magnetism of bottom samples, rocks, etc., by means of the spinning magnetometer presented to Dr. Arley by Prof. M. A. Tuve, of Washington; to organize a comprehensive and systematic geophysical survey of Greenland.

Micro-organism Culture Collections in Canada

THE Specialist Conference on Collections of Micro-organisms, held in London during August 1947, recommended that "a directory of important Culture Collections in the Commonwealth should be prepared" and that "each institution maintaining a culture collection should prepare and distribute a catalogue . . .". H.M. Stationery Office recently published a "Directory of Collections and Lists (not a Catalogue) of Species of Micro-organisms maintained in the United Kingdom and Crown Colonies", and also one for New Zealand. These were modest publications, reflecting the paper situation in Great Britain. Now comes a "Directory and Catalogue of Collections in Canada", published by the Canadian National Research Council, which is sumptuous by comparison. The paper is good, the printing spacious, and the loose-leaves, rather larger than crown octavo, are contained in a durable plastic binder. Most of the Canadian collections are not large enough to justify separate catalogues, and all are combined in the present volume. The organisms are arranged in five sections: bacteria, bacteriophages, viruses, yeasts and fungi. For the bacteria the nomenclature

suggested in Bergey's Manual (sixth edition) has been followed, not always with the whole-hearted approval of the authors; but, in the words of the preface, "they have graciously submitted in the interests of uniformity". The volume has a good index. It might well serve as a model for future directories and catalogues of culture collections.

Ultrasonics: Proceedings of the 1950 Convention at Rome

The proceedings of the International Convention on Ultrasonics held in Rome during June 1950 (see *Nature*, 166, 143; 1950) have now appeared in a volume of some seven hundred pages issued as a supplement to *Nuovo Cimento* ("Atti del Convegno Internazionale di Ultracustica". Bologna: N. Zanichelli; 7000 lire). The papers are printed in the language in which they were read and have been classified in five sections: general accounts of work in specific laboratories; fundamental problems; applications in industry; applications in biology; and applications in medicine. The majority of the papers do, in fact, deal with 'applied ultrasonics', except that a number of the papers in the first two sections are predominantly of a physical nature. Since the volume is a collection of a hundred papers, it is only possible here to indicate the trends of recent work in ultrasonics by noting the predominant fields in which advances are proceeding. On the applied side, some interesting papers describe recent methods of efficiently generating and detecting the radiation, which will be of value to those wishing to apply ultrasonics to specific problems. It is clear that ultrasonics is proving a valuable tool not only for the study of the molecular properties of all states of matter in the laboratory, but also in the industrial test laboratory. A considerable group of papers in German is devoted to studies of the biological effects and possible medical applications of this radiation, a subject somewhat neglected since the pioneer work of the nineteen-twenties, but now resuscitated with the discovery of more powerful and efficient sources and better methods of control and dosage. The volume forms, indeed, a text-book on applied ultrasonics which should be in the hands of all those interested in this rapidly expanding field.

French Documentation Centres and Services

A list of documentation centres and services in France has been issued under the auspices of the United Nations Educational, Scientific and Cultural Organization and the direction of the Library Service of France ("Répertoire des Bibliothèques de France"; pp. 288. Paris: Bibliothèque Nationale, 1951; 450 francs). The list forms the third of three volumes on French library resources, of which the first two, dealing with the libraries of Paris and with the libraries of the Departments, appeared in 1950 and in 1951, respectively, and meets a need to which the International Federation of Documentation has already directed attention. The list, which is planned on a wider basis than that prepared and published in 1935 by the French Union of Organizations for Documentation, includes services as well as centres of documentation, and is based partly on visits as well as on questionnaires sent to some two thousand organizations. Particulars of 309 organizations are listed, including 127 serving public bodies, 40 serving private commercial or industrial firms, and 132 serving economic or commercial associations, etc. Of these, 248 are located in Paris, 24 in the Communes of the Seine and Seine-et-Oise, and 37 in the provinces. The details of each centre or service are arranged alphabetically by the subject or field covered and include particulars of the special interests served, the broad nature of the documentary holdings, conditions of access, classification used and publications issued. There are also an alphabetical index of organizations and an adequate subject index. A prefatory note by M. Julien Cain, administrator-general of the National Library and director of the Libraries of France, emphasizes the incompleteness of the list due to absence of returns from various organizations, including some Ministries.

Colour Measurement for the Non-Specialist

A useful booklet, with coloured illustrations, entitled "The C.I.E. International Colour System Explained" is a simple explanation of the international system for the description of colour, written for the non-technical reader, and showing its value for colour specification in industry (pp. 34; Salisbury: Tintometer, Ltd., 1951; 5*s*.). The book is written by G. J. Chamberlin, the managing director of a firm noted for its speciality in the field of colour measurement, and the international system referred to is that approved by the 1931 Commission Internationale de l'Éclairage. Previous knowledge of the subject is not required of the reader, and the author proceeds by easy stages in a concise and clearly expressed manner; but it is doubtful whether the reader will fully appreciate the significance of the scheme without some background knowledge of physics and mathematics. The booklet consists of two sections. In the first, the various scientific terms, such as hue and brightness, which are usually employed in colour measurement, are briefly defined, and a description is given of both the additive system of colour mixing and subtractive colour formation, although only the former is used in the C.I.E. system. In the second section, the reader is introduced by stages first to the simple equilateral colour triangle, then to the spectral locus, stimuli, the equilateral C.I.E. triangle, the rectilinear C.I.E. triangle and finally to the C.I.E. chromaticity chart, the form in common use. The kind of colour and the proportion of colour, that is, hue and saturation, are thus completely specified; but before a complete description of a colour can be given, a figure for the luminance, the total amount of light in the colour, must be added. It is usually expressed as a percentage reflexion or transmission. Equal chromaticity triangles are discussed next, and the nomogram for converting readings on a Lovibond–Schofield tintometer directly into C.I.E. values is reproduced. The more mathematical sections, together with examples of how to calculate the colour arithmetically and technical details of the three standard illuminants, are given in the appendixes, which also include a short but carefully chosen selection of references for further reading on the subject of colour measurement.

Britain's Forests

Two more of the attractive Forestry Commission publications have recently been issued. The first is one of the "Britain's Forests" series and describes the State forest of Loch Ard. This is one of the largest in Scotland and centres on the town of Aberfoyle on the borders of Perthshire and Stirlingshire, extends northwards to Ben Venue, the Trossachs, Loch Achray and Loch Venachar, westwards to the slopes of Ben Lomond, and southwards to the

bleak high moors above Drymen and Loch Lomond; Loch Katrine lies just beyond its northern boundary, and on its eastern marches stand the Menteith Hills. Besides a description of the forest and the people who live in it, the booklet contains a map of Loch Ard and its surroundings which would be useful to travellers. The second booklet is one of the guides to Britain's forest parks, in this case the New Forest. Here the treatment is fuller and, besides many fine photographs and a specially adapted ordnance survey map, the booklet contains chapters by specialists on the history, geology, botany, zoology and the policy of the Forestry Commission towards the New Forest. There is also a useful collection of general information to assist the visitor as well as a guide to further reading. Both booklets may be obtained from H.M.S.O.; the former costs 1*s.* and the latter 2*s.* 6*d.*

Commercial Agreements in Research and Development

THE commercial world is shot through and through with agreements, ranging from mere verbal undertakings to extensive federations and confederations. In a valuable pamphlet entitled "Commercial Agreements" (Cambridge: Bowes and Bowes; 3*s.* 6*d.*), Mr. Glyn Picton describes the forms and contents of some of these types of agreements between firms. He points out that the stimulus to co-operation is strong when the product is one of technical complexity or when manufacturing processes involve heavy commitments in fixed capital devoted to particular forms, patterns or qualities. An advance by one manufacturer in product design or in productive operations can have serious effects upon sales or costs. Collaboration which enables a firm to participate in discoveries made by another reduces the burden of expenditure on research and facilitates co-ordination of development work and cross-fertilization of ideas. Agreements generally provide for exchange of information on research and development and of rights to use resultant products and processes. The scope of these agreements is inherently difficult to define though the problem is simplified if patents are involved. Where they are not, the alternatives are either to make only a brief expression of intentions or to enter into elaborate provisions defining fields, territories and objects.

Lower Cretaceous Marine Fossils in the 'Nubian Sandstone' of Egypt

A REPORT by M. I. Attia and G. W. Murray, published recently in the *Abstracts of Proceedings of the Geological Society of London* (No. 1482, p. 37), records the recent discovery by the latter of fossiliferous marine bands in the 'Nubian Sandstone' of Wadi Qena in the Eastern Desert of Egypt. The sandstones rest directly on the granites, etc., forming the Red Sea Hills, and are succeeded by Middle and Upper Cretaceous limestones and other sediments. Some of the newly discovered fossils came from intercalations near the base of the sandstones, the rest from higher beds; they indicate a Cenomanian age, but include three ammonites from near the base which, according to Dr. G. H. Awad, suggest an Albian, and possibly an Aptian, age. The late Dr. W. F. Hume made somewhat similar discoveries farther up the Wadi some forty years ago. Fossiliferous marine Lower Cretaceous strata are known in northern Sinai and northern Egypt, to which the new localities and their fossils are an important addition.

Primitive Astronomy

THE September 1951 issue of the *Irish Astronomical Journal* (1, No. 7; 1951) contains a very comprehensive article by A. P. Fitzgerald, with the title "Some Aspects of Primitive Astronomy". It includes a survey of the astronomy of the Chinese, Chaldæans, Egyptians and the Greeks up to the days of Ptolemy. The article is illustrated by a number of photographs and diagrams. Although there is nothing original in this account of ancient astronomy, it provides an excellent summary which will be of great assistance to all who wish to pursue the subject further, and for this purpose the bibliography at the end will be useful.

Belgian Biochemical Society

THE Belgian Biochemical Society (Société Belge de Biochimie; Belgische Biochemische Vereniging) has recently been formed, and the first general meeting was held in Brussels on January 12. The Society has two objectives: the organization of scientific meetings, at which members can discuss the results of their latest work and give experimental demonstrations; and the establishment of friendly relations with similar societies in other countries, particularly with the view of the organization of joint meetings. It is proposed to publish the proceedings of the Society in the *Archives internationales de Physiologie*. Prof. M. Florkin has been elected president of the Society, and the secretary is Claude Liébecq, 17 Place Delcour, Liège.

National Science Foundation Grants for Research in Biological Sciences

THE National Science Foundation (2144 California Street, N.W., Washington 25, D.C.) has recently announced that, under its programme for the support of basic research in the sciences, it has made twenty-eight grants, totalling 410,000 dollars, in the field of the biological sciences. This amount represents slightly less than forty per cent of the funds available to the Foundation for the support of basic research for the current fiscal year. Additional proposals are being considered by the staff of the Foundation with the help of an advisory panel drawn from more than fifty leading American men of science serving as consultants. Grants have been made to institutions in California, Connecticut, District of Columbia, Illinois, Indiana, Kansas, Maryland, Minnesota, Mississippi, Pennsylvania and Wisconsin; the research fields are biochemistry, enzyme chemistry, biophysics, systematic biology, microbiology, aquatic biology, experimental embryology, genetics, immunology, experimental plant biology and photosynthesis. The duration of the grants ranges from one to five years, with an average length of 2·3 years.

Scientific and Technical Journals published in South-east and South Asia

THE Unesco East Asia Science Co-operation Office, Manila, has issued a "List of Scientific and Technical Journals published in South-east Asia" (pp. 32, 1951). The List, which was compiled in 1950, gives the titles, publisher and address and price (with approximate exchange-rates) of those scientific and technical journals published in the Philippines, Indonesia, Malaya, Thailand, Indo-China and Hong Kong. The journals are listed first alphabetically, with title only, according to country, and second, again under country but with full details and

arranged under the following fourteen main headings: general science; zoology, fisheries, oceanography; botany; geology, mining, geography, meteorology; medicine; dentistry; pharmacy; nutrition; veterinary science; agriculture; forestry; engineering, chemical engineering; education; and economics. Of the 142 titles, thirty-one fall under agriculture, twenty-one under medicine, eighteen under geology, etc., seventeen under general science, and eleven under zoology, fisheries, oceanography.

Premio Europeo Cortina Ulisse

The international cultural magazine *Ulisse*, directed by Maria Luisa Astaldi and Rafaele Contu, promoted in 1949 the Premio Europeo Cortina Ulisse to be awarded to a scientific publication published during the past five years. In 1952 the Prize of one million lire will be assigned to a work on biochemistry considered exclusively in its relation to the human organism, and with special emphasis on its applications to medicine. Only works published in the last five years in Europe in any European language will be taken into consideration. The works must be submitted either by the author or by the publisher to the management of Rivista Ulisse (Sezione Premio Europeo Cortina Ulisse, Corso d'Italia, 43, Rome) not later than April 15, 1952.

Asiatic Society: Officers for 1952

Officers and members of council of the Asiatic Society for 1952 have been elected as follows: *President*, Prof. S. K. Mitra; *Vice-Presidents*, Prof. M. Z. Siddiqi, K. P. Khaitan, Sir Paul Benthall and Dr. S. C. Law; *General Secretary*, Prof. J. M. Sen; *Treasurer*, Hon. Mr. Justice R. P. Mookerjee; *Philological Secretary*, Dr. N. Dutt; *Joint Philological Secretary*, Said Ahmed Akberabadi; *Physical Science Secretary*, Dr. D. M. Bose; *Biological Secretary*, Dr. J. L. Bhaduri; *Anthropological Secretary*, Rev. Dr. W. G. Griffiths; *Historical and Archæological Secretary*, Dr. U. N. Ghoshal; *Medical Secretary*, Dr. K. N. Bagchi; *Library Secretary*, Dr. S. L. Hora; *Members of Council*, Dr. J. N. Banerjee, Sir J. C. Ghosh, Dr. J. B. Auden, Nirmal Kumar Sen and Noel Barwell.

Royal Sanitary Institute: Annual Health Congress

The annual Health Congress of the Royal Sanitary Institute will be held in Margate during April 22–25, with Lord Moran as president. The Congress will be divided into eight sections (*A*–*H*) and four conferences (1–4) as follows: section (*A*) preventive medicine, (*B*) engineering and architecture, (*C*) maternal and child health, (*D*) veterinary hygiene, (*E*) food and nutrition, (*F*) housing and town planning, (*G*) tropical hygiene, and (*H*) hygiene in industry; conference (1) medical officers of health, (2) engineers and surveyors, (3) sanitary inspectors, and (4) health visitors. The Congress is not confined to members of the Institute; the fee for non-members is two guineas, or half a guinea per session. Further details can be obtained from the Royal Sanitary Institute, 90 Buckingham Palace Road, London, S.W.1.

French Summer School in Aerial Photogrammetry

The École Nationale des Sciences Géographiques, which is attached to the Institut Géographique National, is organizing a special summer school in aerial photogrammetry to be held in Paris during June 23–August 1. The course will consider both theoretical and practical aspects and has been devised to enable students in other countries who already have a working knowledge of the principles of aerial photogrammetry to become acquainted with the methods and equipment used in France. The instruction will be given in French. The fee for the course, exclusive of accommodation, will be 20,000 francs. Application forms, to be completed not later than May 25, can be obtained from the Director, École Nationale des Sciences Géographiques, 35 Boulevard des Invalides, Paris 7e. A brief outline of the course can be obtained from the Scientific Office, French Embassy, 22 Wilton Crescent, London, S.W.1.

Announcements

Prof. A. G. Walker, since 1947 professor of mathematics in the University of Sheffield (see *Nature*, 159, 89; 1947), has been appointed professor of pure mathematics in the University of Liverpool in succession to Prof. J. M. Whittaker, who has been appointed vice-chancellor of the University of Sheffield.

Trinity College, Cambridge, is offering as in former years a number of research studentships and Dominion and Colonial exhibitions, which will be tenable from October next onwards. The research studentships are open to graduates of universities other than Cambridge (non-graduates of exceptional ability will be considered) who are not more than twenty-six years of age, although in the computing of age any period of national service can be deducted. The exhibitions are open to undergraduates as well as those wishing to undertake postgraduate work. Applications, to be sent through the head of the candidate's university, must reach the Senior Tutor, Trinity College, Cambridge, not later than May 1.

The Zoological Society of London is offering a limited number, not exceeding six, of research studentships to senior undergraduates reading zoology, tenable during the summer vacation, for a minimum period of four weeks at the Society's Gardens, Regent's Park, or at Whipsnade Park, where laboratory and other facilities are provided. Work which includes observations on living animals will be given preference; experiments requiring licences are not allowed. Grants in aid of travelling expenses and a subsistence allowance for those living away from home may be awarded. Applications, supported by the head of the department in which the applicant works, giving particulars of the applicant's age and attainments and a brief outline of the work proposed, should be sent before April 19 to the Scientific Director, Zoological Society of London, Regent's Park, London, N.W.8.

As in former years, a course in tropical hygiene for laymen will be held by the Ross Institute of Tropical Hygiene (forming part of the London School of Hygiene and Tropical Medicine) during July 14–18. The course is for workers in the tropics holding, for example, administrative or executive posts, whose responsibilities entail the health and welfare of other people. Morning sessions of the course will be devoted to malaria and its control, and in the afternoons other tropical diseases and problems such as hookworm, bilharzia, nutrition, housing and sanitation, and protection against heat will be dealt with. There is no fee for the course. Further information can be obtained from the organizing secretary, L. G. Ponsford, Ross Institute of Tropical Hygiene, Keppel Street, Gower Street, London, W.C.1.

A HIGH-RESOLUTION SURFACE-PROFILE MICROSCOPE

By Prof. S. TOLANSKY
Department of Physics, Royal Holloway College (University of London), Englefield Green, Surrey

IN a paper (not yet published) read to the Conference on Contrast in Interferometry and Microscopy, held in Paris in April of last year, I described a further development of the familiar medium-power Schmaltz light-slit microscope through which effective very high magnifications (greater than × 2,000) were easily obtained both in extension and in depth. The particular method there described, capable of realizing the full resolving-power of an oil-immersion objective, uses a Vickers projection microscope, a simple slit being placed against the field iris. The key point of that instrument was the use of the triangular built-in metal tongue reflector to give an off-centre incident beam. The ordinary glass reflector does not give a light-slit picture. The magnification in depth was determined by a calibration using a small indentation the depth of which was evaluated by multiple-beam interferometry. With a 2-mm. oil-immersion lens, it turned out, by chance, that magnification in depth and in length was almost the same, hence the line profile picture exhibited but little distortion and was effectively a true profile section.

Since almost all the objective is in full use, details both in extensions and in depths of the order of $\lambda/2$ are resolvable. A valuable extension of the system will be described here. It is anticipated that this improved technique will have particular value in the examination of (*a*) crystal surfaces, (*b*) engineering machined precision surfaces. As an example of a 'difficult' surface a light-slit picture is shown in Fig. 1 (× 1,000) for a fine-finished, diamond-turned, very soft white-metal cylindrical bearing (2 in. diameter).

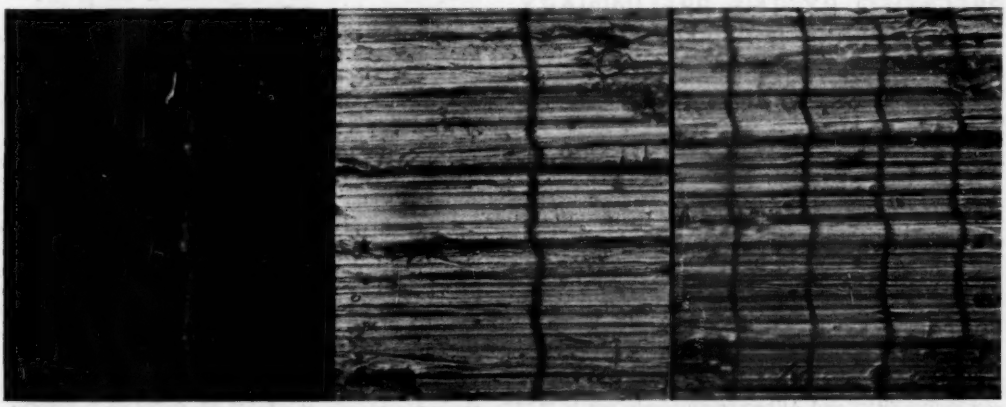
The slit used was a fine line scratched on a piece of smoked glass, and, although the pattern is undoubtedly a very valuable profile, yet it suffers from two drawbacks : (*a*) the scatter at the metal surface leads to a broadening of the image of the slit, and (*b*) the whole field is, of course, dark (apart from the slit image), and hence the precise location of the profile on the surface is not known. In fact, a second photograph with slit removed is needed for superposition to ascertain this.

It is the purpose of this communication to describe how considerable advances have been made by the simple device of reversing the illumination, using a bright field crossed by a dark line, instead of a light slit on a dark field. Several methods using this principle have been found equally effective. Thus it suffices either to stretch a fine wire across the iris opening, to scratch a line on a glass plate, to use a commercial scratched glass graticule, or a photographic graticule, etc. There is no severe demand at all on fineness or precision of this line, as is clear from the optics, since even at × 2,000 the line image itself is but slightly magnified.

Fig. 2 shows the same region as in Fig. 1, using this time the bright field. The considerable advantage is obvious. The scatter does not effectively broaden the dark-line image—if anything, it narrows it slightly—and definition is superior to that of the bright slit. Nor is the image chopped by the non-specular region, which is a disturbing feature in the normal light slit. But a principal gain lies in the fact that the whole field in the objective is revealed and the precise location of the profile is obvious.

Because of this, one can go a step further and replace the single dark line by a coarse graticule of parallel dark lines (a very inexpensive item), with the result shown in Fig. 3. This multiple profile picture represents a very real advance, since all other types of profilometer, for example stylus instruments, give only a ***single*** line profile at any one recording. It is the advantage of interference contour patterns that they reveal in one picture the contour of a whole area, and all other methods of producing profile hitherto have suffered in comparison since they yield information for a single line section. It is of much interest that Fig. 3 does, in fact, reveal profiles over an extended area, and thus combines the advantages and ease of interpretation of line profilometers with those of area interferograms.

It should be emphasized that the optical systems described here can be used with any surface-illuminating microscope if the glass reflector be suitably silvered to give an off-centre pencil. Nor is oil-immersion essential ; in fact, for coarser structures a 4-mm. objective or even a lower power is desirable, otherwise 'depth of focus' troubles are met with. Monochromatic light must be used, for the off-centre



(1) Light slit, dark field (× 1,000). (2) Light profile, bright field (× 1,000). (3) Multiple light profile, bright field (× 1,000)

pencils lead to severe chromatism; a green-filtered mercury source is admirable. It is necessary to calibrate each particular objective if quantitative data are needed. The optical method has the merit of being non-destructive, whereas a diamond stylus may damage the surface, especially a soft metal bearing, such as has been used here. This is an important advantage in many cases, and the cost of modifying the microscope is negligible.

Although a detailed study of the ultimate attainable resolving-power has not yet been made, it is clear from the reproductions given here (certainly clear on the originals) that structure details even somewhat smaller than $\lambda/2$ are resolvable. Thus real magnifications of $\times$ 2,000 are usable and good definition is still obtainable at $\times$ 4,000, although such a figure contains some empty magnification. The procedure therefore conveniently follows on studies made by interferometry but is much easier to carry through.

The technique is now being used in my laboratory for the study of surface features on quartz, diamond and silicon carbide crystals and has already proved of value. It has also been used to solve an old problem, namely, the precision measurement of the depths of hardness indentations. This permits the measurement of elastic recovery too. A separate report on hardness measurements will shortly be published. Other obvious applications come readily to mind.

My thanks are due to my technician, J. O'Farrell, for much help in connexion with the development of these optical systems. [Nov. 12.

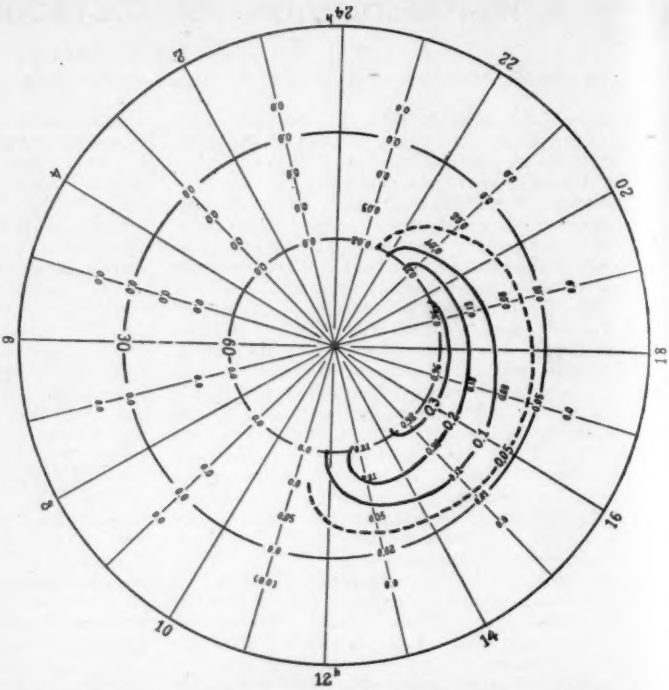


Fig. 1. Distribution of the ratio of the preliminary reverse impulse to the main impulse of sudden commencements with preliminary reverse impulse in the co-ordinates of geomagnetic latitude and local time

SUDDEN COMMENCEMENTS PRECEDED BY THE PRELIMINARY REVERSE IMPULSE IN A GEOMAGNETIC FIELD

By Prof. TAKESI NAGATA
Geophysical Institute, University of Tokyo

BEGINNING with H. W. Newton[1], the diurnal frequency variation of sudden commencements (*SC*), especially of those preceded by the preliminary reverse impulse (*SC**), have been examined by many investigators. V. C. A. Ferraro and his colleagues[2] have suggested that the frequency of occurrence of sudden commencements with preliminary reverse impulse may be subject to the geomagnetic longitude, being a minimum around Honolulu and a maximum for Europe. With regard to this point, W. Jackson[3] and S. K. Chakrabarty[4] have reported negative results for Sitka and Alibag respectively, while R. A. Watson and D. H. McIntosh[5] at Lerwick obtained a result agreeing well with Ferraro and Parkinson's expectation.

One of the main problems will be to decide whether or not the occurrence of the preliminary reverse impulse depends upon geomagnetic latitude, longitude and also on local time, and what the relation is, if any.

I am of opinion that the magnitude of the preliminary reverse impulse and its ratio to that of the main impulse will be significant in these problems. Fig. 1 shows the relation of the mean value of the ratio p/m with local time and geomagnetic latitude (where p denotes the magnitude of the preliminary reverse impulse, while m is that of the main impulse, both in the horizontal component). The data used here are the printed magnetograms from Sitka, Cheltenham, Tucson, San Juan and Honolulu during three and a half years from January 1946 to June 1949, published by the U.S. Coast and Geodetic Survey. From the data during the period mentioned above, sixty-seven magnetic storms having sudden commencements with or without preliminary reverse impulses could be picked out at each station.

Fig. 1 gives a fairly definite result, namely, the ratio p/m depends on local time as well as on the geomagnetic latitude. It seems that the preliminary reverse impulse appears principally in the afternoon, being a maximum around 16 h. local time, and that its ratio to the main impulse increases markedly with the geomagnetic latitude, as suggested in ref. 2. The same statistical procedures were carried out with respect to the absolute magnitude of p and also to the ratio p/m in the horizontal intensity only, that

is, without regard to the change in declination. The results in both cases were almost the same as those shown in Fig. 1.

The same conclusion is also derived from Fig. 2, for example, which illustrates the world-wide distribution of the equivalent current arrows corresponding to the preliminary reverse impulse as well as to the main impulse for the sudden commencement of the magnetic storm on April 30, 1933. As will be seen in this diagram, the preliminary reverse impulses appeared on the afternoon side (chiefly Europe in this case) and their magnitude was large around the auroral zone. Two other examples were also examined, and the results of the analyses agreed well with Fig. 2, so far as concerns the distribution of sudden commencements with preliminary reverse impulse with respect to local time and geomagnetic latitude.

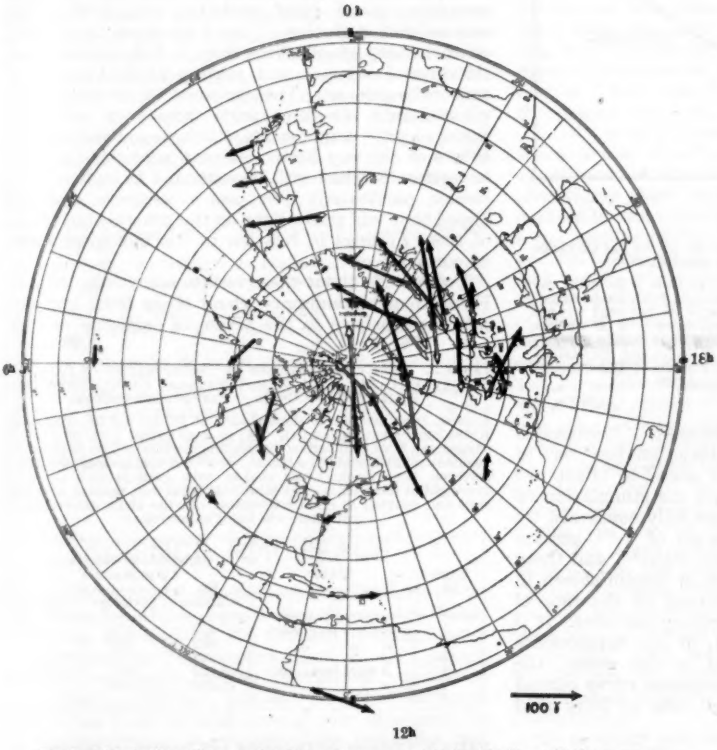


Fig. 2. Distribution of the overhead current arrows equivalent to the preliminary reverse impulse (white arrows) and to the main impulse (black arrows) of the sudden commencement of the magnetic storm on April 30, 1933

It may be urged that the data used here are not so extensive as those studied by Newton or by Ferraro and his colleagues; but I believe that the conclusion about the qualitative characteristics of sudden commencements with preliminary reverse impulse (*SC**) obtained here may far exceed the limits of the statistical errors. [Oct. 20.

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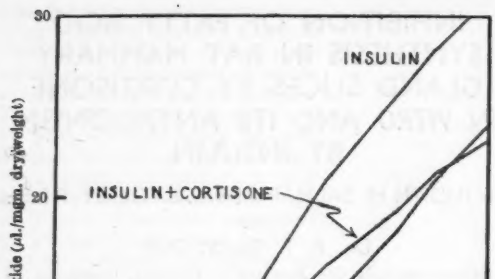
INHIBITION OF FATTY ACID SYNTHESIS IN RAT MAMMARY GLAND SLICES BY CORTISONE *IN VITRO* AND ITS ANTAGONISM BY INSULIN

By JUDITH H. BALMAIN, Dr. S. J. FOLLEY, F.R.S., AND Dr. R. F. GLASCOCK

National Institute for Research in Dairying, University of Reading

IT has long been known that insulin and the C_{11}-oxysteroids of the adrenal cortex (for example, cortisone) exert antagonistic effects in intermediary metabolism, a phenomenon illustrated in a general way by the anti-diabetogenic effect of insulin and the diabetogenic effect of cortisone. Since insulin, acting *in vitro*, has been shown to increase the rate of lipogenesis from acetate by slices of lactating mammary gland[1-3] and liver[4], it seems possible that the lipogenic process might prove to be a site of action of this hormonal antagonism. Indeed, Brady, Lukens and Gurin[5] have shown that pretreatment of rats with cortisone decreases the incorporation of 1-^{14}C-acetate into the fatty acids of slices of their livers. By both respiration and isotope-incorporation studies we have now demonstrated opposite *in vitro* effects and mutual antagonism of insulin and cortisone on lipogenesis by slices of mammary gland, a tissue which is peculiarly suitable for studying lipogenesis *in vitro*.

(*a*) *Respiration studies.* We have used a technique which has proved useful in previous studies of the lipogenesis-promoting action of insulin *in vitro*[1], consisting essentially of measuring the total gas exchange of fully-lactating rat mammary gland slices incubated in Warburg vessels in Krebs bicarbonate-saline in equilibrium with 95 per cent oxygen and 5 per cent carbon dioxide, and containing glucose + acetate as substrate. The curve of total pressure with time (composite curve) so obtained is a resultant of oxygen uptake, carbon dioxide output and carbon dioxide shift between buffer and gas phase due to acid changes. Results of one such experiment shown in the accompanying graph illustrate the unequivocal effect of insulin in increasing the slope of the composite curve, and the opposite and equally marked effect of cortisone. The antagonism between the two hormones when present together



Antagonistic effects of cortisone and insulin on the gas exchange of lactating rat mammary gland slices

Approx. 150-mgm. batches of tissue slices from a lactating rat (13 days) shaken at 37° in Warburg vessels in 3-ml. Krebs saline-bicarbonate (*p*H 7·4) in equilibrium with 95 per cent oxygen and 5 per cent carbon dioxide and containing 0·02 *M* sodium acetate and 0·3 per cent glucose. Crystalline insulin ('Novo') added to final concentration of 2·5 μgm. (0·05 I.u.)/ml. Crystalline cortisone (free alcohol) was shaken with medium (0·25 mgm./ml.) overnight at room temperature

in the medium is clearly indicated. Deductions made from previous respiratory studies as to the ability of mammary gland slices to effect net fatty acid synthesis *in vitro*, and the stimulation of this process by insulin, have been fully confirmed by measurements of the incorporation of 1-^{14}C-acetate into the fatty acids of mammary slices[5,6], and there can be no doubt that the action of insulin shown in the graph signifies an enhancement of the rate of lipogenesis with increased respiratory quotient. It is therefore virtually certain that, in the experiments exemplified by that illustrated in the graph, the decrease in the slope of the composite curve caused by cortisone means a decreased rate of fatty acid synthesis by the slices.

Table 1. Effects of Insulin and Cortisone on Respiration of Lactating Rat Mammary Gland Slices

Measurements made by method of Dickens and Simer (ref.[7] 9). Number of rats (14–16 days of lactation), 6; approx. weight of slices in each cup, 85 mgm.; substrate, 0·02 *M* sodium acetate + 0·3 per cent glucose; gas phase, 95 per cent oxygen, 5 per cent carbon dioxide; medium, Krebs bicarbonate-saline (*p*H 7·4); temp., 37°; duration of experiments, 2 hr.; crystalline insulin ('Novo') added to 50 μgm. (1 I.u.)/ml.; crystalline cortisone (free alcohol) shaken with medium (0·5 mgm./ml.) overnight at room temp. 'Extra CO_2' ($Q_{O_2} + Q_{CO_2}$) = carbon dioxide evolved in excess of that produced by complete oxidation of the substrates (*R.Q.* = 1) and is a rough measure of net fat synthesis

Addition	$-Q_{O_2}$	Q_{acid}	Respiratory quotient	'Extra CO_2'
None	8·6	−0·5	1·39 ± 0·04	3·3
Insulin	9·7	−1·7	1·89 ± 0·03	8·6
Cortisone	6·4	−1·0	1·27 ± 0·04	2·2

Results in harmony with this conclusion have been obtained by measurements of respiratory quotients, $-Q_{O_2}$ and $-Q_{acid}$ (≏ acetate uptake), of fully lactating rat mammary gland slices. Table 1 gives mean results for experiments on six lactating rats, which show that while insulin increases respiratory quotients, $-Q_{O_2}$, $-Q_{acid}$ and 'extra CO_2' as found previously, cortisone has opposite effects. In this system an increase in respiratory quotient and 'extra CO_2' almost certainly signifies an increase in the rate of net fat synthesis and vice versa[6].

(*b*) *Studies with labelled acetate and labelled glucose.* Table 2 shows the results of five experiments, three on mammary gland slices from rats killed on the twentieth day of pregnancy and two on tissue from rats killed early in lactation, which show that cortisone, added *in vitro*, significantly decreases the incorporation of carbon-14 into the fatty acids of mammary gland slices incubated with 1-^{14}C-acetate and unlabelled glucose. Table 3 gives results obtained on mammary gland slices from a fully-lactating rat (12 days) incubated with tritium-labelled acetate + carbon-14-glucose. The amounts of isotope incorporated into the fatty acids from both substrates again clearly demonstrate the antagonistic *in vitro* effects of the two hormones on lipogenesis. Further experiments, which will be extended to include other tissues, particularly liver, are in progress, and it is hoped they will throw light on the general significance of these findings in relation to the biological action of cortisone.

Two points about these results are worthy of note. First, though mammary gland slices from pregnant rats are sensitive to the action of cortisone *in vitro*,

Table 2. Effect of Cortisone on Incorporation of Carbon-14 into Total Fatty Acids of Rat Mammary Gland Slices metabolizing $CH_3{}^{14}COONa$ + Unlabelled Glucose

Approx. 1-gm. batches of slices shaken at 37° for 3–6 hr. with 10 ml. Krebs bicarbonate-saline (*p*H 7·4) in equilibrium with 95 per cent oxygen and 5 per cent carbon dioxide and containing 0·02 *M* carbon-14 labelled sodium acetate (0·5 μc./ml.) + 0·3 per cent glucose. Crystalline cortisone (free alcohol) was shaken with medium (0·5 mgm./ml.) overnight at room temp. The total fatty acids were isolated as calcium salts and counted at infinite thickness. In the blank determinations the tissue was killed at zero time

Expt. No.	Stage	Carbon-14 in fatty acids, c.p.m./mgm. C		
		No addition	Cortisone	Blank
1	20 days pregnancy	403	176	25
2	20 days pregnancy	652	234	7
3	20 days pregnancy	407	173	7
4	2 days lactation	5,422	1,901	14
5	4 days lactation	16,146	3,398	54

Table 3. Effects of Cortisone and Insulin on Incorporation of Tritium and Carbon-14 into Total Fatty Acids of Lactating Rat Mammary Gland Slices metabolizing CT_3COONa + ^{14}C-glucose

Approx. 2-gm. batches of slices shaken at 37° for 3 hr. with 20 ml. Krebs saline-bicarbonate in equilibrium with 95 per cent oxygen and 5 per cent carbon dioxide and containing 0·02 *M* CT_3COONa (0·05 μc./ml.) and 0·3 per cent ^{14}C-glucose (0·01 μc./ml.). Crystalline cortisone (free alcohol) was shaken with medium (0·1 mgm./ml.) overnight at room temp. Crystalline insulin ('Novo') was added to 0·5 μgm. (0·01 I.u./ml.). The total fatty acids were isolated as calcium salts, combusted, the tritium estimated as tritiobutane (ref. 10) and the carbon-14 dioxide counted in an internal gas counter

Addition	Carbon-14 in fatty acids		Tritium in fatty acids	
	c.p.m./mgm. C	% of control	c.p.m./mgm. water	% of control
None	365	100	283	100
Cortisone	254	70	77	27
Insulin	795	218	430	152
Insulin + cortisone	383	105	118	42

as shown by measurements of the incorporation of carbon-14, we have found them inert to insulin by the criterion of measurements of the respiratory quotient[2]. Secondly, we have observed effects due to cortisone on the composite respiration curve of mammary gland slices from 20-day pregnant rats, which surprisingly are in the opposite direction from that expected from the carbon-14 measurements, cortisone changing the gradually falling composite curve, characteristic of slices taken at the end of pregnancy, into a rising one[7,8]. Evidently the well-authenticated interpretation of the composite curve, which applies to experiments with fully-lactating tissue, does not hold for tissue taken at the end of pregnancy. Further experiments, now in progress, may clear up this apparent discrepancy.

We are indebted to Dr. Helen Porter, of the Research Institute of Plant Physiology, Imperial College of Science and Technology, for the preparation of the carbon-14 starch, from which the labelled glucose was made, to Dr. K. Hallas-Møller, of Novo Terapeutisk Laboratorium, Copenhagen, for crystalline insulin free from glycogenolytic factor, and to Dr. C. C. Porter, of the Merck Institute for Therapeutic Research, Rahway, N.J., for crystalline cortisone (free alcohol). We are also indebted to Mr. B. W. E. Peaple for skilled technical assistance.

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SCIENCE FOR PEACE

A CONFERENCE was held during January 19–20 in London of the organization Science for Peace, which was attended by 180 scientific workers.

In opening the first session Prof. F. G. Gregory reviewed the work of the provisional committee formed just a year ago, and reported that sufficient support has been secured among men of science to call this conference to reconsider the principles laid down and to place the organization on a permanent national footing.

Mr. F. le Gros Clark introduced a discussion of principles. He stressed the moral responsibilities of the man of science for the use to which scientific discoveries are put. The public, he said, looked to the scientist for enlightenment, and were apt to blame him for the apprehensions which they feel. "We can no longer pretend to be simpletons experimenting and designing for the mere love of the work in a world that will forgive us if one day the roof blows off. In this situation is it not our responsibility to give what guidance we can?"

After lengthy discussion, a statement of principles was adopted. Recognizing the danger of a third world war the statement runs, "we are determined to do what we can both as citizens and as scientists to prevent it, and to re-establish peace throughout the world. We think it our duty to ensure that science is used solely to improve the conditions of life and to advance the arts of peace". It is the scientist's duty "to inform and enlighten the public both about the benefits that science can bring, and about the destructiveness and misery of modern war; to make what contribution he can towards an understanding of present international tensions; and to urge peoples and governments to work for a negotiated, reasoned and enduring settlement that will prevent a recourse to the increasingly destructive weapons of another war". The statement ends: "We assert the permanently international character of science. It is a world-wide republic of the mind. The scientists of all countries form one fraternity united in a common effort to understand nature; they could be united in a common concern for human betterment. We must seek to maintain everywhere the civil rights of scientists; and it is our duty to strive for the removal of all barriers that restrict or embarrass the free intercourse of scientists and the free interchange of scientific information throughout the world".

In the second session, Prof. K. Lonsdale spoke on the activities to be pursued. She recounted her own experiences in different peace organizations over the past thirty years, and emphasized the importance of each individual facing squarely his or her own personal responsibilities. Scientists must be prepared to talk to groups of all kinds, to do this themselves and not to rely upon a few distinguished speakers. What people want to hear about is not the horrors of atomic warfare, not the A.B.C. of atomic energy, but dispassionate analyses of present deadlocks, and expert suggestions as to what can be done about it. The discussion which followed concerned the formation of local groups of Science for Peace in universities and other laboratories, to hold discussions at which policy questions can be resolved and to organize meetings and other activities whereby agreed policies can be carried to other scientists and to the general public. The *Bulletin* already issued by the provisional committee is to be continued.

In the third session two important resolutions were passed, the first concerning biological warfare. Taking due regard that research directed to defence against biological attack presupposes simultaneous research into the use of biological weapons, and that, particularly when conditions of secrecy are imposed, it may not be possible to prevent such knowledge from being applied, the resolution calls on H.M. Government:

(1) to enter into negotiation with other Governments with the view of a general formal repudiation of any use of biological warfare and to working out practical measures to ensure that this repudiation is effective;

(2) to refrain from imposing conditions of secrecy upon workers at any government-sponsored research institute engaged in work which might bear upon the problems of biological warfare; and to allow inspection of such institutes by accredited representatives of a recognized international organization;

(3) to secure the full publication of the results of all such research, including secret work already completed, whether or not it was directly concerned with biological warfare.

Recommendations (2) and (3) were contingent on recommendation (1); unilateral abrogation of all secrecy was not intended.

A second motion directed attention to the essential need for the elimination of atomic weapons and for a strict international control and inspection of atomic installations. It stated that the differences in policy on international control between the various countries are not as great as has sometimes been suggested and are capable of resolution by compromise. It continued: "In particular, the stress that has been laid on international ownership of large-scale atomic establishments is not justified. Although such ownership might facilitate control it is not essential for effective control. Since it constitutes a major stumbling block we respectfully suggest to our Government that it should use its influence to secure that this proviso is not allowed to hold up a general agreement".

Further resolutions were passed establishing a National Committee and deciding that membership shall be open to natural and social scientists, technologists, engineers and technical assistants and to students taking appropriate courses. Members may join individually or through groups. The twenty-five members of the National Committee include Prof. L. Rosenfeld, Prof. A. C. Offord, Prof. F. G. Gregory, Mr. N. W. Pirie, and Prof. J. D. Bernal. Prof. Kastler and Dr. Grillot were present as fraternal delegates from the French organization "Mouvement des Universitaires Français devant la Menace d'une Nouvelle Guerre Mondiale". Both addressed the conference, and stressed that peace organizations must achieve extensive international contacts.

Summing up the conference, Prof. C. F. Powell said that the whole of West-European scientific tradition from the time of Bacon and Descartes is based on the view that by means of science it is possible to enrich life. The current tendencies towards secrecy and victimization may sap our scientific life like a wasting disease and completely undermine the scientific traditions of Great Britain. In so far as we contribute to the release of tension among the nations, we contribute not only to the safety and independence of our country, but also to the support and sustenance of the great scientific tradition in which we have been fostered and to removal of the suspicion that scientists are indifferent to the often revolutionary consequences of their own discoveries.

F. G. Gregory

ABRASION AND WEAR OF MATERIALS

A SYMPOSIUM on the "Abrasion and Wear of Materials" was held under the auspices of the British Society of Rheology on January 4 at the Polytechnic, Regent Street, London. Of the six papers delivered, three, read in the first session, dealt with hard inorganic materials; the remaining three were devoted to the abrasion and wear of rubber, textiles and leather.

The symposium was opened by M. W. Thring (British Iron and Steel Research Association, London), who was chairman for the morning session. In the afternoon, Dr. V. G. W. Harrison (Printing, Packaging and Allied Trades Research Association, Leatherhead) was in the chair. In the first paper, P. Grodzinski (Diamond Research Laboratory, Industrial Distributors, Ltd., London) described "Three Years Experience with a New Micro-Abrasion Tester". Mr. Grodzinski has developed a tester, primarily for determining vector-hardness differences in diamond surfaces, which has, however, proved useful for most hard materials. The equipment comprises essentially a sharp-edged, doubly conical wheel of 1 in. radius, made of sintered carbide impregnated with diamond dust and revolving at 10,000–15,000 r.p.m., against the edge of which the sample is pressed by a balance arm at low load. The dimensions of grooves cut in 1–15 sec. at given pressures serve as measures of hardness, and in the case of hard materials such as diamonds, rubies and carbides, these are linearly related to their hardness as determined by conventional methods.

Dr. K. H. R. Wright (Mechanical Engineering Research Organization, Department of Scientific and Industrial Research, Glasgow), in a paper entitled "Fretting Corrosion", described a series of experiments of a fundamental nature, in which he carefully controlled environmental and mechanical conditions such as humidity, surface adsorption of oxygen, etc. The oxide initially formed in the fretting corrosion of steel was Fe_3O_4, but ultimately α-Fe_2O_3 was found. Experiments were carried out with steel submerged in British Pharmacopœia paraffin which was either free from water or saturated with it. In each case the formation of α-Fe_2O_3 could be inhibited, but this was not possible if the metal was immersed in *n*-hexane, an inert liquid with a high content of dissolved oxygen. Lubricated, phosphated steel surfaces were very resistant to fretting corrosion, but nickel-plating, contrary to belief, was ineffective as inhibitor.

A paper entitled "The Wear of Wire-Drawing Dies" was read by J. G. Wistreich (British Iron and Steel Research Organization, Sheffield), whose research is directed towards reducing materially the frequency of failure of sintered-carbide wire-drawing dies, for failure is at present a source of considerable economic loss by causing periods of enforced idleness in wire-drawing mills. The most serious form of failure is 'ringing', in which ring-shaped cavities are formed near the die entry and exit. Carbide grains loosened in that region detach themselves on drawing the wire, scoring the latter in the process and facilitating damage to subsequent dies. Evidence from a statistical analysis of die-failures shows that, although short die-lives are prevalent in the correlation of frequency with lengths of die-lives, a tail exists in the distribution curve at its long-lives end. This indicates that a practical solution might be found, most probably by improving the methods and means of die-lubrication.

Speaking on "Elementary Aspects of Rubber Abrasion", Dr. A. Schallamach (British Rubber Producers Research Association, Welwyn) said that the scratch-traces produced by the movement of a loaded needle, and the corresponding tractive force-time records, depend pronouncedly upon the nature of the compounds under investigation. Traces on pure gum vulcanizates are always continuous, but those on carbon-loaded compounds of the tyre-tread type are discontinuous. Abrasion patterns have proved to be an important clue to the actual mechanisms by which abrasion of tyres occurs on the road.

Dr. T. H. Morton (Courtaulds, Ltd., Bocking, Essex), in a paper on the "Wear and Abrasion of Textiles", said that, since the application of an abrasive to a textile material can produce a hole similar to that resulting from wear, there exists a tendency to equate abrasion with wear, though it is

now known that wear can be ascribed to abrasion, flex-fatigue and the mechanical unravelling of the fabric structure, with abrasion not necessarily the most important contributor. Energy is absorbed by the fabric in abrasion, which fact provides the keystone to the recent theories of Hamburger in which tensile and abrasion properties are correlated.

H. Bradley (British Boot, Shoe and Allied Trades Research Association, Kettering), speaking on "The Abrasion and Wear of Leather", surveyed the progress made in this field in recent years. In spite of much work it has not so far proved possible to design wear-testing equipment for the rapid assessment of the wear of leather under practical conditions, and the issue of free shoes to schoolboys still provides the most reliable means for wear-testing. Dimensional analysis was suggested by Mr. Bradley as a possible basis for future research. P. FELTHAM

EARTHQUAKES DURING 1951

DURING 1951 fourteen earthquakes caused major damage and casualties. The swarm of shocks which started on Boxing Day 1950 continued daily in the Leeward Islands during January. On Nevis, severe damage was done to the library, the hospital and to most public buildings, as also to two churches, two or three schools and the school feeding-centre. Demolition was necessary in some cases, and there was concern over the water supply. On St. Kitts two banks, the treasury and the hospital, together with some private houses and business premises, were damaged. Most of the people in these islands live in small wooden houses, which were not damaged by the shocks, and fortunately there was no loss of life or food shortage.

In New Zealand a swarm of shocks occurred during January at Cheviot, a small town sixty miles north of Christchurch. The first shock, on January 10, had magnitude 5·6 on the Richter logarithmic scale, and there followed some twenty-five other strong shocks during the month. Most of the chimneys in Cheviot were down, the telephone service was temporarily out of order and the Blenheim–Christchurch railway was temporarily blocked by a landslide.

A series of tremors, culminating in two strong shocks on January 14, caused heavy property damage at Angrado Heroismo in the Azores.

On March 14 earth tremors rocked parts of France, Belgium, Holland and Germany. The epicentre was probably in the Eifel plateau, and at Euskirchen the walls of a school cracked and the chimney fell down. Minor property damage in the area was extensive. On April 8 an earthquake near the coast of Turkey (37° N., 35° E.) caused casualties amounting to six killed and ten injured.

Four destructive earthquakes occurred during May. On May 6 approximately a thousand people were killed, four thousand injured, and twenty thousand rendered homeless by the earthquake which wrecked the town of Jacuapa in the Republic of El Salvador. Jacuapa is some seventy-five miles east of San Salvador. On May 10 a tremor shook southern Rhodesia, and a further twenty-four tremors continued to shake the same area during the month. A large landslide was caused by the earthquakes in the Chimanimani mountains. On May 19 an earthquake near Cordova in Spain caused such damage to the convent of St. Francis that it later collapsed. No casualties were caused, as the building had been evacuated following the initial damage. On May 31 an earthquake off the north coast of Luzon (19° N., 121° E.) in the Philippine Islands caused slight property damage, and injury to one person.

On July 9, near the east coast of Oaxaca, Mexico, one person was killed as a result of an earthquake at Miahuatlan.

On August 13, at 18h. 33m. 40s. G.M.T., a strong earthquake occurred in the Black Sea, off the coast of Turkey. In the district of Kurshunlu in the province of Changari, several villages were razed and the official report states that 3,354 houses were destroyed, resulting in 50 people being killed and 208 injured. On August 21 an earthquake with epicentre near the west coast of Hawaii caused some damage to property on the Kona coast.

On October 22, at 03h. 29m. 26s. G.M.T., Formosa was shaken by a tremor which proved to be the first of a series of more than forty heavy and more than ninety minor earth tremors. The main business centre of Hualien was wrecked ; more than twenty bodies were recovered from the debris. Houses were also damaged in Tainan and Taichung. Reports state that approximately a hundred people were killed and eight hundred injured in the island. Again, on November 12, earth tremors damaged the port of Hsinkiang on the east coast of Formosa, but on November 24 a series of shocks, the greatest being at 18h. 50m. 19s. G.M.T. (Richter logarithmic magnitude 7¼), once more shook the east coast, causing major property damage and the deaths of twelve persons. Several others were injured.

Of the earthquakes so far mentioned, only the last-named attained a Richter logarithmic magnitude greater than 7, but all happened in populated districts. During the year, six other earthquakes, with epicentres in unpopulated areas, attained a Richter logarithmic magnitude greater than 7. These were on February 17 in south-east New Guinea (7¼), March 10 in the New Hebrides (7¼), March 23 in the Kermadec Islands (7·1), November 6 in the Kurile Islands (7¼), November 18 in eastern Tibet (7¼), and December 8 in the Indian Ocean, about nine hundred miles south-west of Madagascar (7¾). During the year seven earthquakes had a depth of focus greater than 250 km. These occurred on February 9 in the Pacific Ocean between Tonga and the Kermadec Islands (600 km.), March 23 (previously mentioned) in the Kermadec Islands (300 km.), July 11 in the Bonin Islands region (550 km.), August 2 near the New Britain Islands (500 km.), August 10 off the north coast of Hokkaido (Japan) (300 km.), August 28 in the Kermadec Islands region (600 km.), and November 12 south of the Fiji Islands (400 km.).

The above account is based on information received from the International Seismological Association (Strasbourg) and co-operating observatories, the Jesuit Seismological Association of Observatories (headquarters St. Louis, United States), the United States Coast and Geodetic Survey with its seismological observatories, Stuttgart and the adjoining stations, Zurich and the Swiss observatories, Wellington and the New Zealand observatories (including Fiji), Aberdeen, Belgrade, Cleveland (Ohio), De Bilt (Netherlands), Durham, Karlsruhe, Kew, Mizusawa (Japan), Pasadena, Perth (Western Australia), Toledo and Trieste. ERNEST TILLOTSON

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Estimation of Plant Growth Substances by Partition Chromatography

The extensive researches on plant growth substances have not provided a simple method for the characterization or estimation of the small quantities of these substances which occur in the extracts of natural products[1,2].

Considerable uncertainty surrounds the claim that auxin *a* is present together with indole-3-acetic acid in urine and certain plant tissues, and various forms of growth promoters and growth inhibitors have been claimed to be found in plant tissues. These claims, in addition to recent work in this laboratory[3] postulating growth-inhibiting and growth-promoting substances, made desirable a simple technique for the characterization and separate quantitative estimation of growth promoters and inhibitors.

Recently, the counter-current method of separation has been used by Holley *et al.*[4] and has given indications of the identity of natural plant growth-active material with indole-3-acetic acid, and Linser[5] has made use of adsorption chromatography on alumina columns.

Neither of these techniques is so versatile and so simply applicable to fairly small amounts of material as is paper partition chromatography. Pilot experiments with pure indole-3-acetic acid, indole-3-propionic acid and indole-3-butyric acid showed that these three could be separated from each other in mixtures. Of many partition solvents tried, *iso*-propyl alcohol : water : : 10 : 1 was found most useful, for with it indole-3-acetic acid gave a convenient R_F value, the spots produced were not diffuse and a good separation of the three indole-aliphatic acids could be obtained. Work with other solvents showed, as might be expected, that the R_F value for indole-3-acetic acid increased in acid and decreased in alkaline conditions; also it decreased with the chain length of the alcohol used in the solvent. For most of the present work the chromatograms were run under alkaline conditions by placing the solution, *iso*propyl alcohol : water : ammonia (D = 0·880) : : 10 : 1 : 1, in the base of the chromatographic tank. Under these conditions and at 25° the R_F values were indole-3-acetic acid = 0·52, indole-3-propionic acid = 0·59, indole-3-butyric acid = 0·66.

The indole derivatives were most satisfactorily detected on dried chromatograms by spraying with 5 per cent perchloric acid, 50 parts, and 0·05 *M* ferric chloride solution, 1 part. With this spray the following spot colours were obtained: indole-3-acetic acid, crimson; indole-3-propionic acid, pink-brown; indole-3-butyric acid, orange. The logarithm of the areas of these spots was found to be proportional to the concentration applied in the starting spot, over the following ranges: indole-3-acetic acid 0·25–8 μgm., indole-3-propionic acid 2–20 μgm., indole-3-butyric acid 2–20 μgm. The lower concentrations correspond with the smallest spots which could be conveniently marked at their edges and their areas measured; however, smaller concentrations could be detected qualitatively.

The quantitative estimation of indole-3-acetic acid on a developed chromatogram was also done biologically, and by this procedure the presence of other growth-promoting or -inhibiting substances may be revealed. The method was to cut the chromatogram into squares, 2·5 cm. × 2·5 cm., and place these in small 'Pyrex' dishes with 3 per cent fructose or sucrose solution, 2 ml., and subapical sections of *Avena* (var. Victory from Svalof) coleoptiles. The extension after twenty-four hours in darkness at 21° C. was measured. Ready elution from the paper squares occurred, and the percentage extension of the coleoptiles over their original length was shown to be proportional to the concentration of indole-3-acetic acid in the starting spot of the chromatogram. The relationship is roughly logarithmic. The expected position of an indole-3-acetic acid spot on a chromatogram of unknown material was defined by running a parallel chromatogram with known indole-3-acetic acid and developing the spot with the perchloric acid – ferric chloride spray.

When a chromatogram of an ether extract of urine was run, marked acceleration of growth was obtained by the eluate from the region of the indole-3-acetic

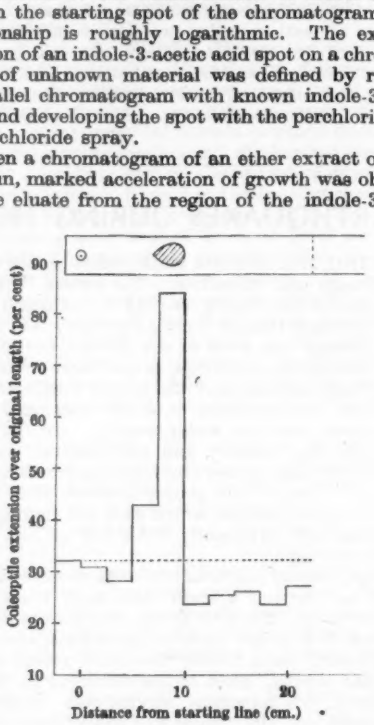

Fig. 1

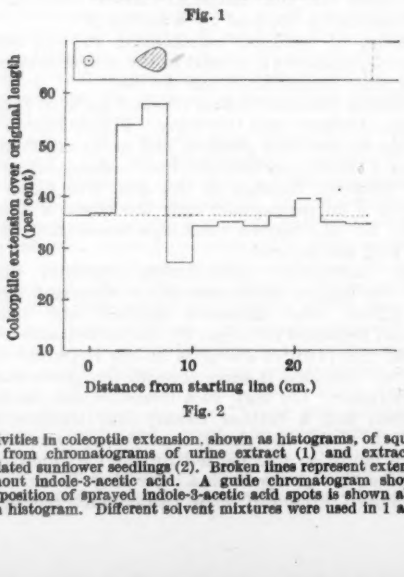

Fig. 2

Activities in coleoptile extension, shown as histograms, of squares cut from chromatograms of urine extract (1) and extract of etiolated sunflower seedlings (2). Broken lines represent extension without indole-3-acetic acid. A guide chromatogram showing the position of sprayed indole-3-acetic acid spots is shown above each histogram. Different solvent mixtures were used in 1 and 2

acid spot as Fig. 1 indicates; but no other growth-active region of the chromatogram was found. Since we thought some loss of indole-3-acetic acid might occur on running chromatograms in air, this was repeated in a nitrogen atmosphere without any different result. This may not establish with certainty the absence of auxin *a* as there is the possibility of its having extreme instability on a chromatogram; but in a nitrogen atmosphere this would seem less probable.

In plant material, for example, etiolated sunflower seedlings, indole-3-acetic acid was clearly detected on biological analysis of a chromatogram of the anionic fraction of the ether extract, see Fig. 2. Here it may be noted that active extension growth was obtained from the eluate of the indole-3-acetic acid region only. Indication of the presence of an inhibitor having an R_F slightly larger than indole-3-acetic acid is also shown.

This technique affords a ready characterization of indole-3-acetic acid far more specific than diffusion measurements or tests of stability in acid or alkaline media, because the separations effected are due to partition coefficient or solubility differences and may be checked by a reasonably specific spot colour reaction. Simultaneously with this separation and characterization, indole-3-acetic acid and other growth promoters and inhibitors may be quantitatively assayed.

T. A. Bennet-Clark
M. S. Tambiah
N. P. Kefford

Department of Botany,
King's College,
Strand, W.C.2.
Jan. 17.

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Mechanism of Blood Coagulation

None of the theories of blood coagulation can explain some important anomalies without the introduction of hypothetical factors which have yet to be isolated. Their disadvantages are most apparent when an attempt is made to correlate:

(*a*) the one- and two-stage method of prothrombin estimation;

(*b*) the difference between the use of Russell viper venom plus lecithin and brain thromboplastin in the one-stage prothrombin estimation;

(*c*) the apparent increase in prothrombin concentration in hæmophilic blood after clotting;

(*d*) an apparent auto-catalytic generation of thrombin after clotting has commenced.

Electrophoretic studies upon normal plasma freed from prothrombin or fibrinogen, or both, suggested that, although these substances exist in plasma in a free state, a greater proportion exists as a 'prothrombin' – fibrinogen complex. It also appears that the fibrinogen of this complex clots rapidly with thrombin, but the 'prothrombin' part of the complex is inactive until the fibrinogen is acted upon by a part of a thrombin complex (which I have previously called 'thrombin *A*'), formed from free prothrombin in the plasma. The substance which forms the complex with fibrinogen is called 'prothrombin' here, but may or may not be identical with the free form of prothrombin.

The following observations are presented in support of the above conception.

(1) If the above is true, the serum from the one-stage prothrombin method of Quick (immediately after the formation of a clot) should show increased prothrombin instead of none as always accepted. This increase in prothrombin can be shown by a prothrombin consumption test. If further prothrombin conversion is checked by the addition of excess oxalate (*p*H 7·3) immediately after a clot is formed, thrombin present clots a prothrombin-free plasma in 16–20 sec. If physiological saline is added in place of oxalate to the serum from the one-stage prothrombin test, a clotting time of 7–8 sec. is found when the prothrombin consumption test is performed within 20 sec. This is similar to the readings found in hæmophilia; but, unlike in hæmophilia, the residual prothrombin of normal blood can be converted to thrombin rapidly.

(2) When fibrinogen is removed from plasma by the addition of dilute thrombin (clotting time 45 sec.), the expressed serum shows a greater prothrombin concentration than the original plasma. The prothrombin concentration measured by the addition of prothrombin-free plasma, brain thromboplastin and calcium ions gives a prothrombin time of 6–8 sec. The use of Russell viper venom plus lecithin as a thromboplastic agent gives similar results with whole plasma. Other experiments also indicate that Russell viper venom can split the suggested 'prothrombin' – fibrinogen complex.

(3) If normal plasma is treated with Russell viper venom and fibrinogen is then prepared by precipitation, it is found that this fibrinogen clots much more slowly with thrombin than fibrinogen prepared from untreated plasma.

(4) The prothrombin time using Russell viper venom plus lecithin as a thromboplastic agent gives similar results to: (*a*) the prothrombin consumption test in hæmophilia (8 sec.), (*b*) the two-stage prothrombin estimation method, and (*c*) tests using the 'serum prothrombin conversion accelerators'. Yet the same prothrombin activity can be shown in plasma from which fibrinogen has been removed by negligible amounts of thrombin, even though previously the prothrombin estimated by the one-stage method was far less. (The standardized thromboplastin used in all these experiments was not as potent as Quick's, as it gave a 14–15 sec. prothrombin-time compared with Quick's 11–12 sec.)

(5) In hæmophilia there is the enigma of the constant 8-sec. prothrombin consumption-time in many cases. This can be explained by the liberation of prothrombin once clotting has occurred, since there is little thromboplastic activity in hæmophilia.

I believe that the free prothrombin is responsible for the prothrombin-time as estimated by Quick's one-stage method, whereas the splitting of the prothrombin – fibrinogen complex is responsible for many anomalies noted in various prothrombin estimation tests.

The experiments which support this theory of blood coagulation, together with some on pathological plasma, will be published in full elsewhere.

Raymond N. Lyons

Department of Surgery,
University of Sydney.
Sept. 26.

Mechanism of Action of Extracts of the Posthypophysis on Water Transport through the Skin of the Frog (*Rana esculenta*)

The increased transport of water through the skin of the frog under the action of posthypophysis extracts[1] has been explained as due to decreased resistance to the water movement[2]. According to this view, an increased absolute diffusion of water in both directions would be expected.

In order to check this hypothesis, isolated frog skin was placed between a known hypotonic or isotonic heavy water (D_2O) solution (outside) and a Ringer solution of known *p*H (inside). The molar concentration of heavy water inside was determined after a fixed time interval. In parallel experiments the skin was exposed to posthypophysis extracts (0·5 U./ml.) (Postipofisi, from C. Erba Co., Milan) for the same time, in Ringer solution of about the same *p*H value. All the experiments were performed at 28 ± 1° C.

For the determination of heavy water we used the technique of Sapirstein[3]; the molar percentage of D_2O was calculated from the formula:

$$x \text{ per cent} = \frac{1 - \dfrac{d_0}{cd_1'(1 + 3\beta(t - t_0))}}{\dfrac{\left(\dfrac{M_2}{M_1} \cdot \dfrac{d_1}{d_2} - 1\right)d_0}{cd_1'(1 + 3\beta(t - t_0))} - \left(\dfrac{M_2}{M_1} - 1\right)} 100;$$

where t_0 and t are the temperatures at which the diver floats in ordinary water and in the unknown mixture of ordinary and heavy water respectively, d_0 and d_1' are the densities of ordinary water at the temperatures t_0 and t respectively, d_2/d_1 is the ratio of the density of heavy water to that of ordinary water at temperature t, M_2/M_1 is the ratio between the molar weights, 3β is the thermal coefficient of cubic expansion of 'Pyrex' glass ($= 10^{-5}$) and c is 0·999984.

From the outside concentrations of heavy water at time 0 and t (C_2^0 and C_2), supposing that the inflow of water is constant and about equal to the outflow, we can calculate the absolute water transfer outside to inside in ml. per hour (a_{21}) from the formula:

$$C_2 = \frac{C_2^0}{1 + \dfrac{V_1^0}{V_2^0}} + \left(C_2^0 - \frac{C_2^0}{1 + \dfrac{V_1^0}{V_2^0}}\right) \times \exp\left(-\frac{V_1^0 + V_2^0}{V_1^0 . V_2^0} a_{21} t\right),$$

where V_1^0 and V_2^0 are the volumes in ml. of the inside and outside solutions respectively.

Errors due to the difference between volumetric and molar percentages of D_2O, and to the presence of an equilibrium between D_2O and DHO, can be neglected for our purposes.

The experimental results are shown in the accompanying table, from which it appears that the absolute transfer of water from outside to inside is 40–80 times greater than the net water transport[1]. The values for the transport of dilute water are in accordance with those of Hevesy *et al.*[4]. Furthermore, the absolute water transfer does not vary with the saline strength of the outside solution, while the net transport decreases with the saline concentration[1].

Composition of outside solution	Duration of experiment (hr.)	Without posthypophysis		With posthypophysis	
		Inside *p*H	a_{21}/cm.² (ml.)	Inside *p*H	a_{21}/cm.² (ml.)
$H_2O + D_2O$	3·83	7·82	0·215	7·00	0·262
,,	1	8·21	0·262	8·15	0·299
,,	1	7·50	0·310	7·15	0·310
NaCl 6·5‰ in $H_2O + D_2O$	1	6·90	0·209	7·15	0·250
,,	1	7·30	0·260	7·15	0·260
,,	1	7·25	0·305	7·15	0·249

The extracts of posthypophysis do not remarkably alter the absolute transfer of water from outside to inside, although they increase[1] noticeably the rate of net transport of water in the same direction.

It would appear from this work that the posterior lobe principles do not increase the permeability to water in both directions, but that they only increase the inflow of water. This action is presumably only possible with an active mechanism of water transport.

We wish to thank Prof. Bolla and his co-workers of C.I.S.E. (Milan) for the supply of heavy water and scientific assistance, and Mr. F. Poy for technical assistance in carrying out heavy-water determinations.

V. Capraro
G. Bernini

Istituto di Fisiologia,
Università di Milano;
Istituto "C. Erba"
per Ricerche Terapeutiche,
Laboratorio di Biologia,
Milano.

Oct. 16.

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Effect of Diet on the Serum Riboflavin of the Laying Hen

A large number of experiments have been carried out to show that the concentration of riboflavin in the egg of the domestic fowl is directly related to the dietary level[1–3], and Common *et al.*[4] have shown that a considerable increase occurs in the serum riboflavin of the hen at the onset of laying. However, the relationship of the concentration of riboflavin in the blood serum of the laying hen to riboflavin intake does not appear to have been investigated.

In an investigation of the rate of transfer of riboflavin to the chick embryo during development, hens were fed graded levels of riboflavin in order to produce eggs of varying riboflavin content. At the same time, observations were made on the riboflavin content of the blood serum of the experimental hens. Three groups of hens were kept in specially constructed houses with wire floors and fed on a diet of the following composition: maize meal 45, ground oats 30, wheat bran 10, earthnut cake meal 5, blood meal 4, fish meal 2, limestone 1, steamed bone flour 1, salt 0·5, cod liver oil 1·5, with the addition of folic acid and biotin at 0·25 and 0·15 μgm./gm. diet respectively. Two of the groups received supplementary riboflavin at 2·0 and 4·0 μgm./gm. of diet. Blood samples and eggs were collected at random from each group during the course of the experiment.

Group	Riboflavin in diet (μgm./gm.)	Serum riboflavin (μgm./ml.) ± e	Riboflavin in eggs (μgm./gm.) ± e
1	1·56	0·285 ± 0·03	2·31 ± 0·13
2	3·60	0·778 ± 0·07	4·18 ± 0·22
3	5·55	0·880 ± 0·07	4·92 ± 0·22

Fluorimetric assays were carried out on the diets, blood sera and eggs by the method of Kodicek and Wang[5]. The accompanying table shows the results obtained.

It will be seen from these results that the serum riboflavin is substantially increased by supplementing the diet and that the blood-levels are directly related to egg content. An increase in the diet above 3·6 μgm./gm. did not result in a significant increase in serum level; this would appear to be in accordance with the observation of Petersen *et al.*[3] that further increase in hatchability from the inclusion of riboflavin in the diet is not attained beyond this dietary level for battery-kept birds.

W. O. Brown

Agricultural Chemistry Department,
Queen's University,
Belfast,
and
Ministry of Agriculture (N.I.).

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Production of Specific Group *N* Precipitating Sera for *Streptococcus cremoris* by 'Absorption' of Non-specific Antigens

Due in part to the difficulty of preparing a specific group *N* precipitating serum for *Streptococcus cremoris*, the boundaries and constituents of serological group *N* have been so far incompletely determined. Although, by means of serological methods using interfacial precipitin tests with hydrochloric acid extracts, *Str. cremoris* has been grouped with *Streptococcus lactis* by Shattock and Mattick[1], and with *Str. lactis* and with *Streptococcus diacetilactis* by Swartling[2], final confirmation of its serological identity with group *N* must depend on the preparation of a specific group serum for *Str. cremoris* itself.

Early attempts in this laboratory to produce such a serum in rabbits, using as vaccines living and variously heat- and chemically-treated bacterial cells, yielded only non-specific products, cross-reactions occurring most commonly and intensively with hydrochloric acid extracts of the streptococci of groups *K* and *L*. Absorption of these non-specific sera with suspensions of *K* and *L* streptococci completely removed the non-specific antibodies and only partially impaired the group *N* reactions. In order to produce a powerful serum specific in the first instance, it was clearly necessary to inactivate the non-specific antigens in the *cremoris* cells constituting the vaccine before the immunization process was begun. By 'absorbing' *Str. cremoris* cells with sera of groups *K* and *L*, these antigens were eliminated or rendered non-antigenic, and specific group *N* sera were obtained forthwith. Such sera have been prepared for both freeze-dried and freshly isolated strains of *Str. cremoris*.

The details of this work will be published elsewhere.

C. A. E. Briggs

Department of Bacteriology,
National Institute for Research in Dairying,
University of Reading.
Oct. 31.

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Grana-like Structures of *Synechococcus cedorum*

During photosynthetic studies in this laboratory, the desire for an organism possessing a simple internal structure prompted us to investigate the blue-green algæ. It has occasionally been reported that these organisms contain grana or chloroplasts; but the most widely accepted opinion is that all their pigments are uniformly distributed throughout the cytoplasm[1].

A pure culture of a unicellular blue-green alga, *Synechococcus cedorum*, was grown in an inorganic medium, and one-day old cells were used for investigating the pigment distribution. After the cells were harvested by centrifuging and washed with water, they were broken by grinding with alumina[2]. The mixture was diluted with water and centrifuged at 2,000 *g* for 10 min. to remove unbroken cells, cell debris and alumina. A blue-green supernatant having a strong Tyndall effect and slight fluorescence was obtained. This supernatant was then centrifuged in a refrigerated Spinco ultracentrifuge for 30 min. at 36,000 *g*. A clear blue supernatant above a very minute green sediment was obtained. The absorption spectra of the intact cells and of the several fractions were determined from 3500 A. to 7500 A. with a Cary recording spectrophotometer. The curves of the aqueous solutions or suspensions are shown in Fig. 1.

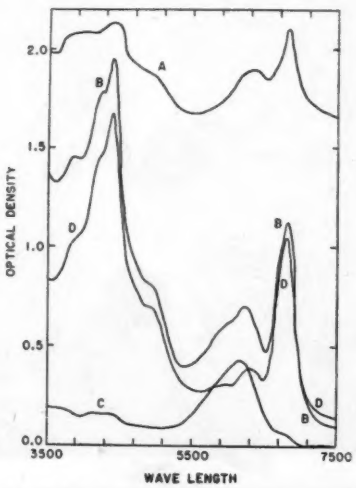

Fig. 1. Absorption spectra of *Synechococcus cedorum*. (*A*) Whole cells; (*B*) supernatant (2,000 *g*) from alumina-treated cells; (*C*), supernatant (36,000 *g*) after ultracentrifugation; (*D*) resuspended particles obtained from ultracentrifugation

The suspension of the green sediment (curve *D*) gives an absorption curve for chlorophyll and carotenoids, and the clear supernatant (curve *C*) shows the absorption spectrum for phycocyanin with no chlorophyll. Centrifugation at 36,000 *g* for 20 min. gives a complete separation of the two groups of pigments, chlorophyll and carotenoids associated with particles and phycocyanin in solution. Breaking the cells by either ultrasonics or nitrous oxide treatment[3] gave the same results as obtained by alumina grinding.

Electron micrographs of the whole cells of *Synechococcus cedorum* and of the green sediment (curve *D*) obtained after breaking the cells by ultrasonics and ultracentrifuging are shown in Fig. 2. The dark areas of the whole cells are believed to correspond to the particles obtained by ultracentrifuging. The polystyrene standards have a diameter of 2600 A., and from this the diameter of the particles in the whole cells appeared to be approximately 2200 A. Therefore, these particles are similar in size to the grana of chloroplasts.

These results show that all the chlorophyll and carotenoids of *Synechococcus cedorum* are associated with particles that are thrown out by centrifuging at 36,000 *g*, and that the phycocyanin is in solution. On the basis of size and chlorophyll content, these particles of *Synechococcus cedorum* might be considered analogous to the grana of other green plants. There is also experimental evidence to indicate that the pigments of the photosynthetic bacteria, *Chlorobium*[4] and *Rhodospirillum*[5], are also aggregated in particles.

We wish to thank Dr. Mary Belle Allen for the pure culture of *Synechococcus cedorum*, and Dr. Robley Williams for taking the electron micrographs.

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M. Calvin
V. Lynch

Radiation Laboratory and
Department of Chemistry,
University of California,
Berkeley.
Oct. 24.

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Fig. 2. Electron micrographs of *Synechococcus cedorum*. (*a*) Whole cells (the polystyrene standard is shown in the lower right corner). (*b*) Particles from broken cells sedimenting at 36,000 *g*, corresponding to curve *D* of Fig. 1. (The completely opaque black circles are the polystyrene standards, diameter 2600 A.)

Eelworm Galls Mistaken for Ergot in Flowers of Canadian Grasses

Specimens of the grasses *Arctagrostis latifolia* (R. Br.) Griseb. and *Dupontia fisheri* R. Br. collected within the past two or three years on Southampton Island and at Chesterfield Inlet, North West Territory, in the far north of Canada, were found by Dr. W. G. Dore and Dr. D. B. O. Savile of the Department of Agriculture, Ottawa, to possess eelworm galls in the flowers, and were sent to me for identification of the causal eelworm. In one of his letters, Dr. Savile directed attention to the fact that Linder[1] had recorded ergot, *Claviceps purpurea*, on *Arctagrostis latifolia* from Southampton Island and Pond Inlet, Baffin Island, and on *Dupontia fisheri* from Chesterfield Inlet, N.W.T. He stated that he himself knew of ergot only on *Elymus arenarius* of the grasses in northern Canada, and suggested that, if the grasses in which Linder claimed to have found ergot were re-examined, it would probably be discovered that the structures taken for ergot were, in fact, galls due to eelworms.

The relevant specimens, collected by Prof. N. Polunin in 1934 and 1936, on which Linder based his determinations, are deposited in the Farlow Herbarium, Harvard University, and a request for their loan was readily granted by Dr. W. Lawrence White, curator of the Herbarium. The material consists of five lots listed below under their catalogue numbers: 129*a*, *Arctagrostis latifolia*, from Hudson Bay Company Post, South Bay, Southampton Island, coll. 23/8/1934; 2293*a*–13, and 2268*a*, *A. latifolia*, from the same site, coll. 22/8/1936; 714*a*–1, *A. latifolia*, from Pond Inlet, Baffin Island, coll. 12/9/1934; 2242*a*, *Dupontia fisheri*, from Chesterfield Inlet, N.W.T., coll. 19–20/8/1936. From each specimen one only of the conspicuous flask-shaped galls was removed, soaked in water overnight and carefully opened under the dissecting microscope by means of needles on the following morning. In all five cases the result was the same: the contents were found to consist of the shrivelled remains of a few adult eelworms together with numerous eggs and eelworm larvæ. Determination of the exact species of eelworm

involved has not, so far, been possible, but it can be stated that it belongs to the nematode genus *Anguina* to which the well-known wheat gall nematode, *Anguina tritici*, and the bent-grass nematode, *Anguina agrostis*, belong. Further investigations are needed in order to determine whether the eelworm giving rise to these grass flower galls in Canada is identical with *Anguina agrostis* or is, in fact, a new species.

T. Goodey

Nematology Department,
Rothamsted Experimental Station,
Harpenden, Herts.
Oct. 31.

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Lysis of *Rhizobium melilotus* in Agar Films by Bacteriophage

Kleczkowska[1] has described a 'physiological ageing' of colonies of *Rhizobium* in an agar layer which renders them immune to attack by bacteriophage after they are 19 hr. old. Thus the multiplication and spread of the phage particles throughout the volume of the plaque must take place within the period set by the ageing of the bacterial colonies.

During a study of phage active against *Rhizobium melilotus* isolated from soils obtained from fields of *Melilotus alba* and *Melilotus officinalis*, it was found that if plates showing plaques are left at room temperature for 10–15 days, an increase in the lysed area takes place; but between this newly lysed area and the original plaque there remains a band of apparently normal, opaque growth. This secondary lysis is not subject to the same factor or factors which sharply limit the size of the original plaques, since expansion of the lysed area appears to take place so long as the medium remains sufficiently moist to allow diffusion of the phage particles through it. After one month, plaques originally 2 mm. in diameter have been seen surrounded by opaque rings 1·0–1·5 mm. wide, which in turn were surrounded by further bands of lysis 5 mm. wide. Where the number of plaques on a plate is such that they are close enough together, the areas of lysis around them will coalesce, thus producing large areas completely denuded of colonies except those in the resistant rings.

Phage can be isolated from these newly lysed areas and from the opaque rings surrounding the original plaques. Attempts to obtain viable organisms from these resistant rings have so far been unsuccessful, indicating that the colonies in them are dead, inactivated by some metabolic by-product, or are again subject to phage action when introduced to liquid medium.

In this work, plates were prepared from 18–24-hr. cultures of the susceptible organism in Campbell and Hofer's medium, mixed with suitable dilutions in saline of homologous phage and incorporated in 0·75 per cent agar medium similar to that used by Kleczkowska[1], but modified by reducing the calcium carbonate to 1 gm. and the *p*H to 7·2–7·4. Incubation for the first 24 hr. was at 28° C., with further incubation at the prevailing temperature of the laboratory.

Some new hypothesis is therefore necessary to replace that of 'physiological ageing' to explain the resistance of the colonies immediately surrounding the plaques. One might attempt to do so by speculating that, during lysis resulting in the formation of the original plaque, some antilysin is produced which renders the surrounding colonies immune. This cannot be the case, since the question immediately arises as to why there is not a repetition when lysis occurs outside the resistant band, thus giving rise to a series of resistant and lysed alternate rings rather than a single widening area of complete lysis. It would appear that some substance or factor results from the interaction of bacteria with phage which can be utilized by the surrounding cells to produce immunity only during their early, active growth. Colonies not affected during this period remain subject to phage attack, but those originally affected retain their immunity indefinitely. What this substance or factor may be, or what conditions are present during this early period, but which disappear or alter with increasing age of the colonies in the agar film are, at the moment, unknown.

This work is part of the programme of the Legume Research Committee in Ontario.

F. H. S. Newbould

Dept. of Bacteriology,
Ontario Agricultural College,
Guelph, Canada.
Oct. 15.

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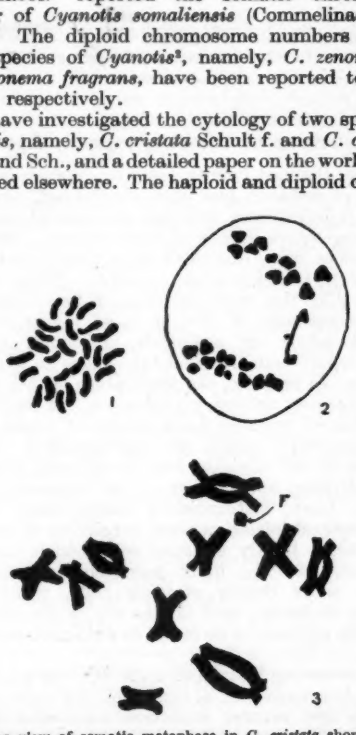
Cytology of *Cyanotis*

Anderson[1] reported the somatic chromosome number of *Cyanotis somaliensis* (Commelinaceæ) to be 28. The diploid chromosome numbers of two other species of *Cyanotis*[2], namely, *C. zenonii* and *C. spironema fragrans*, have been reported to be 16 and 12 respectively.

We have investigated the cytology of two species of *Cyanotis*, namely, *C. cristata* Schult f. and *C. axillaris* Roem and Sch., and a detailed paper on the work will be published elsewhere. The haploid and diploid chromo-



(1) Polar view of somatic metaphase in *C. cristata* showing 24 chromosomes. × 1,650. (2) Inversion bridge in a pollen mother cell of *C. cristata*. × 975. (3) Late diplotene in *C. axillaris* showing 10 bivalents and a fragment. × 1,650

some numbers of *C. cristata* were found to be 12 and 24 respectively (Fig. 1). In the diploid chromosome complement, a fragment was observed in some plates (cf. *Tradescantia virginiana*, *C. zenonii*, *C. somaliensis*, etc.). Irregularities, which included inversion bridge (Fig. 2), multivalents and laggards, were observed in the first division in a fairly large number of pollen mother cells, due to which nearly 46 per cent pollen grains were found to abort. Irregular chromosome behaviour is a regular feature in many genera of the family Commelinaceæ[2], for example, *Tradescantia*, *Rhœo*, *Zebrina*, etc., and the genus *Cyanotis* seems to be no exception.

In *C. axillaris* the haploid and diploid chromosome numbers were found to be 10 and 20 respectively (Fig. 3). No irregularities other than the presence of a quadrivalent and a fragment in a few pollen mother cells were observed (Fig. 3). The sterility of pollen grains was consequently found to be approximately 6 per cent.

The presence of inversion bridge, fragments, etc., in *Cyanotis* suggests that many species of this genus may have been evolved due to spontaneous structural changes undergone by the chromosomes of this genus. There are indications, such as the presence of multivalents, lagging chromosomes, etc., that these two species are polyploids.

Ahmad Shamsul Islam
Abdul Baten

Department of Botany,
University of Dacca.
Oct. 9.

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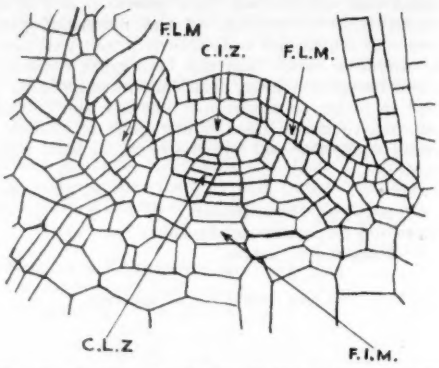
Structure of the Angiosperm Apex

During the past twenty years or so, a considerable amount of research has been carried out, especially in the United States, into the anatomical structure of the vegetative apices of angiosperms. Many of these apices were described in terms of Schmidt's well-known tunica-corpus concept. This concept implied that the apex consists of two zones—the tunica, consisting of one or more layers of cells, where divisions are ordinarily anticlinal, and the corpus, where cell divisions take place in a number of planes. In practice, the application of this concept is an extremely arbitrary procedure. In later years, a number of workers have described zones in the vegetative apex which are distinguished, not by direction of cell division, but by cell size, frequency of cell division and density of cell contents. These workers have distinguished three main zones: (1) the central initiation zone, consisting of comparatively large, lightly staining cells which show few divisions; (2) the flank meristem, consisting of smaller, more deeply staining cells, which show frequent divisions; and (3) the rib or file meristem, where the cells are to be found in well-marked vertical rows.

An interesting feature of some of these accounts[1-2] is the description of a cambium-like zone of cells between the central initiation zone and the file meristem. Popham and Chan[3] suggest that, possibly, the presence of this zone is related to the size of the apex, for a number of relatively small apices have been described that do not seem to possess this cambium-like zone.



Cell-outline drawing of median longitudinal section, vegetative apex of *Arabidopsis*. (× 600)
F.L.M., flank meristem; *C.I.Z.*, central initiation zone; *C.L.Z.*, cambium-like zone; and *F.I.M.*, file meristem

The cell-outline drawing shown is that of a median longitudinal section through the vegetative apex of *Arabidopsis thaliana* (L.) Heynh. The diameter of this apex is about 54 μ and its depth 23 μ, so it must be one of the smallest angiosperm apices to have been described. The three main zones are labelled. The central initiation zone, as usual, consists of fairly large, lightly staining cells. The flank meristem, on the right-hand side of the central initiation zone, consists of smaller, more deeply staining cells. These flank meristem cells present a fairly regular stratified appearance, especially in the two-surface layers. The flank meristem cells on the left-hand side of the central initiation zone still stain deeply; but the stratified appearance has been lost. This reorganization of the cells can be connected with the erection of a leaf primordium on the flank meristem. Periclinal divisions, mainly in the second layer of cells from the surface of the apex, are responsible for the erection of this primordium. One of the most important features of reorganization is the establishment of procambium cells. This foliar foundation with its leaf primordium will later undergo vacuolation, but flank meristem will be re-formed in exactly the same position by the activity of the central initiation zone. The next leaf primordium, to be formed directly above the one in the drawing, will be erected on this new flank meristem. Therefore, one can regard the central initiation as the self-perpetuating region of the apex while the flank meristem is responsible for leaf formation and its associated processes. The deeply staining property of the flank meristem cells is probably associated with the large amount of cell division and cell reorganization that proceeds in the zone.

The *Arabidopsis* apex shows a poor development of file meristem. The vacuolating cells of the zone are arranged in fairly regular vertical rows and are giving rise almost immediately to the highly vacuolate cells of the pith. Between the central initiation zone and the file meristem a cambium-like zone, produced by the lowermost cells of the central initiation zone, can be clearly seen consisting of two layers of dense cells, and three cells wide. It is dividing to produce the cells of the file meristem. This evidence seems to suggest that the presence of the cambium-like zone is not related to apex size for, here, it is present in

an extremely small apex. Philipson[2] and Popham and Chan[3] have also related the presence of this zone to the early and mid-phases of the plastochron and, certainly, in the *Arabidopsis* apex the zone is best marked in the early phase of the plastochron. The development of this zone at the time stated in the growth processes of the apex is to be expected, for its real importance is to produce cells of the future pith of the axis to accompany the developing leaf and the tissues on which the leaf is laid down.

I am indebted to Prof. F. G. Gregory and Mr. G. Hussey for the plant material on which these observations were made.

JOHN G. VAUGHAN

Chelsea Polytechnic,
Manresa Road,
London, S.W.3.
Jan. 8.

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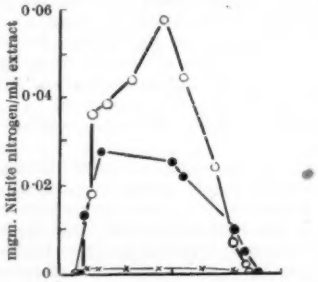
Decomposition of Nitrate in Mixtures of Minced Grass and Water

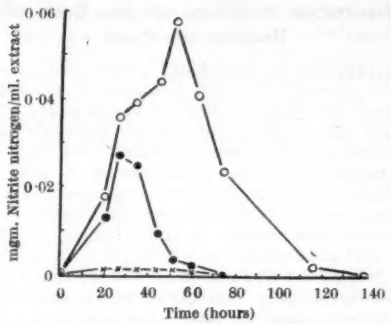
THE addition of various substances, such as amino-acids, has a temporary inhibitory effect on the formation of lactic acid in slurries made from minced grass and water[1]. Among the substances tested in this connexion was potassium nitrate, and it was found, in preliminary tests, that the inhibition was due to the partial formation of nitrite from the nitrate, the former then being decomposed to nitric oxide. The reaction nitrate → nitrite only inhibits the formation of lactic acid temporarily, and when the lactic fermentation reaches a reasonable level, as measured by the fall in *p*H of the mixtures, the second reaction nitrite → nitric oxide takes place.

Unfortunately, it is not possible to measure the lactic acid or lactate content directly by the normal method used[2], because the presence of nitrate or nitrite interferes with the course of the reaction involved[3]. At the same time, as all our studies in this laboratory have shown that in these fermentations the *p*H is extremely closely related to the formation of lactic acid, it is reasonable to conclude that when the *p*H of the mixture to which nitrate has been added attains a level similar to that of the control, the lactic acid plus lactate contents of both are the same. It has been found that this similar level is reached after all the limiting amount of nitrate has been decomposed.



O—O—, Aerated mixture; ●—●—, anaerobic mixture; ×—×—, anaerobic control

Fig. 1. Formation and decomposition of nitrite from nitrate in minced grass/water mixtures at room temperature under aerobic and anaerobic conditions, showing the corresponding fall in *p*H of the mixtures



O—O—, Aerated mixture; ●—●—, anaerobic mixture; ×—×—, anaerobic control

Fig. 2. Results shown in Fig. 1 plotted against time

There are many micro-organisms which could bring about the reaction nitrate → nitrite, and an effort is being made to isolate the one responsible in the experimental conditions involved. At the moment, it appears to have the characteristics of a facultative aerobe, as the reaction proceeds under anaerobic conditions but not to as marked an extent as in aerated mixtures. In Fig. 1 are shown the results obtained by the addition of 5 gm. of potassium nitrate to each of two mixtures, one of which was aerated and the other kept under anaerobic conditions by passing in a continuous brisk current of oxygen-free nitrogen. It will be seen that the reaction starts at about the same point in each case, reaches a much higher peak in the aerated mixture and that, after the decomposition of the nitrite, approximately the same *p*H is reached in each case. Fig. 2 shows the formation and decomposition of nitrite plotted against time. It has been found that the amount of nitrate decomposed in an aerated slurry may be as much as 26 per cent, but only about half that amount is reduced under anaerobic conditions.

The reaction is of interest in view of the findings of Seekles and Sjollema[4] and Bradley *et al.*[5] among others, who have worked on nitrite poisoning in ruminants—a disease sometimes called 'oat-hay poisoning'. Olson and Moxon[6] have found, working with oat hay and red-root, that the reduction of nitrate to nitrite can take place *in vitro* when the material is wet, and these latter workers consider that the reduction may be due to the activity of *Brucellus subtilis*.

A full account of this work will appear elsewhere.

A. JOHN G. BARNETT

Division of Agricultural Biochemistry,
Department of Biological Chemistry,
University of Aberdeen.
Oct. 17.

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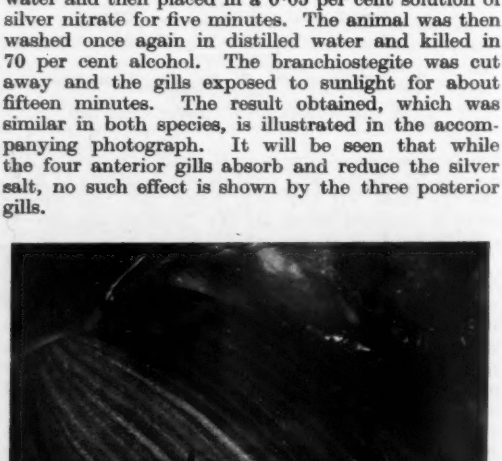
Absorption of Silver on the Gills of a Freshwater Crab

The presence in freshwater arthropods of organs capable of absorbing and reducing silver salts has long been recognized. Koch[1,2] has brought forward evidence that these structures are probably sites of chloride absorption from the water. We have examined the silver-reducing properties of the gills of the two freshwater crabs, *Potamon* (*Potamonautes*) *sidneyi* Rathbun and *P.* (*Potamonautes*) *depressus* (Krauss). Each crab was washed in five changes of distilled water and then placed in a 0·05 per cent solution of silver nitrate for five minutes. The animal was then washed once again in distilled water and killed in 70 per cent alcohol. The branchiostegite was cut away and the gills exposed to sunlight for about fifteen minutes. The result obtained, which was similar in both species, is illustrated in the accompanying photograph. It will be seen that while the four anterior gills absorb and reduce the silver salt, no such effect is shown by the three posterior gills.



P. sidneyi. Branchial cavity showing gills after treatment with silver nitrate

The gills as they lie in the branchial cavity are triangular in section with the apex of the triangle ventral. Almost the whole surface of each lamella is blackened by absorbed silver. Near the middle of the lower face of each lamella is a small area where no absorption occurs. In the entire gill, these latter regions appear as white streaks running along the length of the gill, one on each side of the main gill axis. Similar areas may be recognized on the posterior gills. A detailed examination of the anterior gill lamellæ shows that the silver granules lie in large areas of irregular polygonal shape up to 40 μ in maximal breadth. The boundaries between these areas are sharply defined. Though they have the appearance of pavement epithelial cells, there is no evidence that they, in fact, correspond in any way to cellular structures in the hypodermis.

After exposure to sunlight for several days, the posterior gills also turn brown. The effect is never so intense as with the anterior gills, and the pigment is unevenly distributed. The posterior gill lamellæ do not show the polygonal areas of silver deposit typical of the anterior gills. It seems probable that the silver pigmentation in the posterior gills is to be attributed to small traces of silver which were not washed off the gills after treatment with the silver solution.

Schlieper and Herrmann[3] have shown that in *Potamon* (*Potamonautes*) *potamois* (Olivier) (= *Telephusa fluviatilis* Latr.) the urine is isotonic with the blood, and no special chloride-absorbing zone is found in the green gland. Nor is there such a zone in the green gland of *P.* (*Potamonautes*) *sidneyi*[4]. The occurrence of areas specialized for chloride absorption from the exterior will therefore be expected in this genus. Among other freshwater decapods, Maluf[5] has found silver reduction by all the gills of *Cambarus clarkii* Girard, and we have observed the same effect with the freshwater prawn *Caridina nilotica* (P. Roux), though here there are also chloride-absorbing areas on the inner surface of the branchiostegite, as Koch[1] found in *Palæmonetes varians* (Leach) and *Leander serratus* (Fabr.).

The localization of the silver-absorbing areas to certain gills which we have found in *Potamon* provides an exception to Koch's statement that "tous les organes décrits comme branchies chez les Crustacés . . . absorbent l'Ag"[1]. The significance of this localization has yet to be determined.

D. W. Ewer
Ivan Hattingh

Department of Zoology,
University of Natal,
Pietermaritzburg.
Oct. 11.

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Possible Biological Significance of the Action of Ionizing Radiations on Nucleic Acids

It is now widely recognized that the biological effects of ionizing radiations (X-rays, γ-rays, etc.) are due to chemical changes induced by the radiations.

In vitro doses of the order of 10,000 r. or more are required to produce even relatively small chemical changes, whereas it is well known that 50 r.–100 r. are often sufficient to bring about marked biological effects. To account for this it has been suggested[1] that one may be dealing with the destruction of an enzyme which is present only in very low concentration, or that the radiations produce a very powerful cell poison; although in the latter case relatively large doses should be required to produce an effective amount, except perhaps in 'whole-body' irradiations where this substance may be produced in a relatively large volume, and where it is conceivable that its effect may be enhanced by being afterwards concentrated in the much smaller volume of an 'organ'.

However, there appears to be another possible mode of the biological action of ionizing radiations, which is suggested by some recent work on nucleic acids[2–4]. It has been shown that irradiation of nucleic acids by X-rays in aqueous systems leads to definite chemical changes which manifest themselves in a liberation of ammonia and of inorganic phosphate, and in the formation of other low-molecular fragments[3,4].

A more detailed study, including nucleotides, nucleosides and the constituent bases, has led to the following conclusions regarding the mechanism of these processes[4].

The radicals which are produced by the primary action of the ionizing radiations attack either the base and/or the sugar components of the nucleic acid. In this way some phosphate esters are produced which are relatively unstable and, in particular, tend to undergo hydrolysis with the formation of inorganic phosphate, thus leading to some further degradation of the nucleic acid molecule.

It is clear that the elimination of amino- and hydroxyl-groups will result in a loss of 'hydrogen bonding' which, according to Gulland[5], is largely responsible for the high viscosity of deoxyribonucleic acid solutions. Our own results are in agreement with these views and we have also found some indications[4] that the so-called 'after-effect' which manifests itself in a further loss of viscosity of deoxyribonucleic acid solutions after cessation of the irradiation[6] is due to a slow hydrolysis of some of the labile phosphate esters formed in the primary attack.

On the basis of these experiments, it is suggested that in the biological action of ionizing radiations a relatively small primary attack on, for example, a nucleic acid molecule, possibly followed by processes of hydrolysis, may be already sufficient to make it biologically inactive, at least for its original functions in the living system.

In the case of the biologically important macromolecules, such a mechanism could provide the 'multiplication factor' which is required to understand the relatively high sensitivity of biological systems towards these radiations.

For example, a deoxyribonucleic acid of a molecular weight of about 3×10^6 should give a 'multiplication factor' of the order of about 10^4 if the deoxyribonucleic acid molecule is (biologically) deactivated by the destruction of one of its nucleotide units. Smaller multiplication factors can be easily explained, for example, if more than one 'unit' per molecule is destroyed. In this way, therefore, it would not be difficult to understand the great radio-sensitivity of biological systems on the basis of the known physical and chemical effects produced by these radiations *in vitro*.

Even by considering a primary attack on nucleic acids (or on certain proteins), which are relatively abundant in the cell, some selective reactivity towards the radiations would still be required in view of the presence of a number of other substances which could exert a 'protective effect'. However, there is no real difficulty about this, as it follows on very general physico-chemical grounds that a relatively small difference in the activation energies may be very effective in directing the attack towards a particular substance.

One of the notable features of the mechanism proposed above is that it is non-specific, and it should not matter greatly in which particular way the 'knocking out' of the biologically active macromolecules occurs. This could be brought about, for example, by ionizing radiations, as discussed above, or by other suitable agents.

It is very suggestive that, for example, the action of the so-called 'radiomimetic' nitrogen mustard compounds can be explained on a similar basis, although the mode of their chemical reactivity is evidently different from that of the radicals produced by the ionizing radiations. According to Ross[7] and others, the nitrogen mustard compounds are very effective alkylating agents and can react with the secondary hydroxyl groups and with free amino groups in the nucleic acid molecule. It is clear that alkylation of the polar groups must lead again to a loss in 'hydrogen bonding', which should manifest itself in a decrease of viscosity of deoxyribonucleic acid solutions, as has been observed experimentally.

On the basis of the foregoing discussion, it is possible that the alkylated nucleic acids may be also less stable against hydrolytic and enzymatic attack in general[8].

JOSEPH WEISS

King's College,
(University of Durham),
Newcastle upon Tyne, 2.
Dec. 4.

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A Spectrophotometric Method for the Detection of Blood Stains

In medico-legal practice, blood stains are usually identified by the benzidine and Kastle–Mayer tests, followed by confirmatory specific tests for hæmoglobin as hæmatin or hæmochromogen. The former suffer from the disadvantage that a number of oxidizing agents and plant juices also give positive reactions, while the latter are difficult when the stain is either small, old or badly contaminated. There is therefore a need for a rapid and reliable procedure suitable for blood stains, fresh or old, whether on cloth or admixed with dust. The method described below largely fulfils this need.

The test depends on the fact that potassium cyanide gives cyanohæmoglobin[1] with hæmoglobin, methæmoglobin or hæmatin, and is characterized by an absorption curve with a maximum at 422 mμ and smaller bands at 360 and 550 mμ respectively. The maximum at 422 mμ has ten times the intensity of the visual band at 550 mμ. This makes the ultraviolet examination more sensitive than the visual. The $E(1\%,1\text{ cm.})$ value at 422 mμ is 66 (calculated in relation to acid hæmatin, which is 32·3 based on the iron determination).

The test is applied by putting the suspected stain (as small as 2 mm.^{2}) in 0·5 per cent potassium cyanide for 15 min. and then filtering; the filtrate is put in a 1-cm. cell of a photoelectric spectrophotometer (Unicam) and the absorption curve determined from 300 to 600 mμ. The maximum at 422 mμ indicates the presence of cyanohæmoglobin.

The method can be made quantitative. If it be accepted that the amount of hæmoglobin in blood averages 15 per cent, and the stain in 4 ml. of the reagent gives a reading in the spectrophotometer at 422 mμ of 0·2, then the amount of blood will be

$$\frac{100 \times 0{\cdot}20}{15 \times 66 \times 25},$$

that is, 0·0008 ml.

The test has been successful on stains ranging from 15 min. to several years old. A sample of blood-

------, Cyanohæmoglobin; ———, stain 22 years old. $\lambda_{max.}$ 360, 422·5, 550 mμ

stained cloth (22 years old) from the Medico-legal Department of this University was examined by the above method, and the absorption curve is included in the accompanying graph.

The test has worked successfully with blood stains obtained from a variety of materials such as leather, painted wood, walls, soil and sand, and with stains from cloth either washed with soap and water or contaminated with vegetable juices or rust. In a particular case the stained material (old leather) was undergoing putrefaction and still gave the characteristic curve.

Thus the cyanohæmoglobin reaction appears to be a sure and reliable test for the identification of blood stains.

A. A. Khalifa
M. K. Salah

Departments of Forensic Medicine and Biochemistry,
Faculty of Medicine, Alexandria.
Oct. 1.

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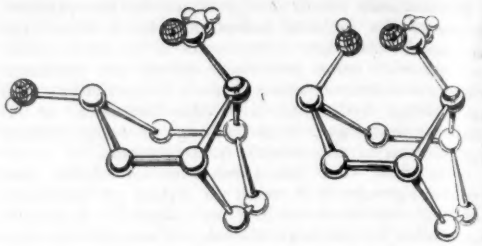
Stereochemistry of Tropine and pseudo-Tropine

Acyl migration N → O was used for the determination of the configuration of the diastereomeric 1.2-amino-alcohols, for example, ephedrine[1], chloromycetin[2], as well as for that of the alicyclic amino-alcohols (2-amino-*cyclo*hexanol and pentanols) containing flexible[3a] or rigid[3b] ring systems by Fodor and Kiss. More recently, McCasland[4] elucidated the configuration of the epimeric inosamines by the same means.

In the case of *nor*-tropine and *nor*-pseudo-tropine, it has so far only been established[5] that in both epimers carbon atom 3 is pseudo-asymmetrical; but it is not known which modification contains a *cis*-placed hydroxyl group and which a *trans*-placed one to the nitrogen atom. Owing to the recent investigations of Kimura and Unna[6a] and of Issekutz and Nádor[6b], respectively, concerning the synthesis of quaternary tropine derivatives of curare-like activity, it seemed of interest to reinvestigate the stereochemistry of the tropines. It was assumed that the



(I) (II)

extension of the method of Fodor and Kiss[3b] and of Fodor and Koczka[3a], respectively, to these heterocyclic epimeric amino-alcohols containing a rigid ring system will render possible the establishment of their configuration. Thus N-benzoyl-*nor*-tropine (II) and its C_3-epimer (I) were prepared. On prolonged standing in dioxanic hydrogen chloride, the ψ-form furnished, by acyl migration N → O, O-benzoyl-*nor*-ψ-tropine-hydrochloride of ammonium salt character, melting point 214°, whereas the epimeric N-benzoyl-*nor*-tropine was recovered unchanged. The same O-benzoyl-compound was prepared from pseudo-*nor*-tropine-hydrochloride, using the common method for the preparation of tropines, that is, action of benzoyl chloride. Treatment with alkali brought about instantaneous rearrangement into N-benzoyl-*nor*-pseudo-tropine owing to reverse acyl migration O → N. For the sake of comparison, O-benzoyl-*nor*-tropine-hydrochloride was also prepared by benzoylation of *nor*-tropine-hydrochloride. This compound, like the natural *nor*-tropine esters, did not undergo acyl migration O → N on action of alkali.

The epimeric N-acetyl derivatives, on the other hand, furnished unstable acid-amide salts, of which N-acetyl-*nor*-ψ-tropine-hydrochloride (II.HCl), melting point 155°, could be isomerized quantitatively at its melting point into O-acetyl-*nor*-ψ-tropine-hydrochloride, melting point 213–214°; whereas N-acetyl-*nor*-tropine (I) hydrochloride[7] was only converted to the extent of 1–2 per cent into the isomeric amino-ester salt (melting point 194°) even at 160°.

The qualitative difference between the behaviour of the benzoyl derivatives of the epimeric *nor*-tropanols and the very great discrepancies in the rate of thermal rearrangement of their acetyl derivatives lead to the conclusion that pseudo-*nor*-tropine, and consequently all pseudo-tropine derivatives, are of *cis*-configuration (II) with respect to the nitrogen and hydroxyl groups, whereas *nor*-tropine and tropine and their derivatives are of *trans* configuration (I).

It is hoped to compare the epimers by means of other stereo-specific reactions. We also hope to elucidate the steric structure of ecgonine and cocaine by analogous means based upon the now established configuration of the tropines. We shall attempt to determine the relative steric position of carboxylic group 2 to hydroxyl group 3 by degradation of ecgonine and ψ-ecgonine into the epimeric 2-amino-3-tropanols and by subsequent investigation of the latter by stereospecific reactions. ***Note added in proof.*** This has now been carried out (lecture by G. Fodor delivered at the annual meeting of the Hungarian Academy of Science, December 11, 1951).

Experimental details will be reported elsewhere. This work was supported by the Hungarian Academy of Science.

G. Fodor
K. Nádor

Institute of Organic Chemistry,
University, Szeged. Sept. 28.

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[7] Prepared by Polonovsky, M., and Polonovski, M., *Bull. Soc. Chim.*, **39**, 1147 (1926), who suggested it had the structure of an acylamide salt; our electrometric titrations proved the correctness of this assumption.

Anion Affinity and Polarizing Power of Cations

It is suggested that the ionization potential, *I* (first for univalent cations, second for divalent cations, third for trivalent cations, and so on), be used as a relative measure of the power of a cation to attract an anion (its 'anion affinity'), and of its polarizing power. Its use thus may be demonstrated by some of the comparisons below. The general concept used here of the ability of cations to polarize and deform anions follows that discussed in the writings of Fajans[1,2] and of others, and the homopolar bonds referred to below are regarded as strongly polarized ionic bonds.

(1) *Univalent ions*

(*I* increases ⟶)

	Cs^+	Rb^+	K^+	Na^+	Li^+	Tl^+	Ag^+	Cu^+	Au^+
I (volts)	3·9	4·2	4·34	5·14	5·4	6·1	7·57	7·7	9·22
Radius (A.)	1·67	1·47	1·33	0·97	0·68	1·47	1·27	0·96	1·37

Radii are included, based mainly on those of Pauling[3], as revised, with additions, by Ahrens[4].

A progressive change in bond type (ionic → covalent) with a given partner (O^{2-}, S^{2-}, Cl^-, etc.) is usually apparent when going from left to right, with thallium frequently occupying an intermediate position. For some purposes of comparison, Li^+ should be omitted because of its small size.

(2) *Medium-sized (0·6–0·8 A.) divalent cations*

(*I* increases ⟶)

	Mg^{2+}	Mn^{2+}	Fe^{2+}	Co^{2+}	Zn^{2+}	Ni^{2+}	Pt^{2+}	Pd^{2+}	Cu^{2+}
I (volts)	15·03	15·64	16·24	17·4	17·95	18·2	19·3	19·9	20·3
Radius (A.)	0·66	0·80	0·74	0·73	0·74	0·69	0·80	0·80	0·72

With increase in anion affinity there is again a progressive change in chemical, crystal chemical and stereochemical properties, and in the ability to form stable complexes. Manganese and nickel frequently occupy positions intermediate between the two extremes, magnesium and platinum, palladium and copper.

The possibility that the coplanar stereochemistry of divalent copper, palladium, platinum (all partners except fluorine) and sometimes nickel could arise as a result of extreme deformation (polarization) of the partner suggests itself as a possible alternative to the concept of hybridization of bond orbitals as postulated by Pauling[5].

When arranged in order of increasing anion affinity, large (0·97–1·20 A.) divalent cations, Ba^{2+}, Ca^{2+}, Pb^{2+}, Cd^{2+} and Hg^{2+}, also show progressive changes of properties as above. These ions have the 8 : 4 (fluorite) structure with the rigid anion F^-, whereas the 6 : 3 (rutile) structure is common for divalent ions of the medium-sized group.

The greatest ionization potential of any divalent metal is that of Ag^{2+} (22·0 volts; radius 0·89 A.) and is a probable cause for the unusual properties of this ion and for the instability of all its compounds, AgF_2 included.

L. H. Ahrens

Department of Geology,
Massachusetts Institute of Technology,
Cambridge, Mass.
Sept. 25.

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Reaction Velocities and Activation Energies of some 'Instantaneous' Complex Ion Reactions

In connexion with an investigation of the slow time reactions in the chromic thiocyanate system in aqueous solution, one of us (J. B.) had the idea that it might be possible to estimate the energies of activation in 'instantaneous' complex ion reactions by investigating the reactions in alcoholic solutions at low temperatures. These expectations have been to a great extent fulfilled.

The introductory experiments were carried out in test-tubes at approximately − 75° C. in a bath of solid carbon dioxide and 96 per cent ethanol in an unsilvered litre Dewar flask, and at about − 100° C. in a bath of melting methanol (made by means of liquid air and kept in circulation by aeration). Various complex systems with strongly coloured complexes were examined visually in methanol solution, and the following new measurable reactions with times of half-completion varying from many hours to a few seconds in 0·05–0·001 molar solutions were discovered:

(1) Ferric ions reacted measurably with thiosulphate to form a stable violet complex, as also with phenols at − 75° C. The colour reaction with sulphosalicylic acid occurred several times faster than with salicylic acid, probably due to the electronegative influence of the sulphonic group.

(2) Nickel ions (Ni^{2+}) gave slow reactions with dimethylglyoxime, pyridine and ethylenediamine at − 75°, while Cu^{2+} reacted in a few seconds with ethylenediamine at − 100° C., but instantaneously with ammonia and pyridine.

(3) Thiocyanate ions gave delayed reactions with $PdCl_4^{--}$, $AuCl_4^-$, $PtCl_6^{--}$, Fe^{3+} at − 75° C. with rates increasing in the order mentioned, and at − 100° C. also with Co^{2+}. Cupric ions still reacted instantaneously at this temperatur e.

(4) Dithizone gave delayed reactions with mercuric, cobaltous and nickel ions at − 75° C. With ferrous ions it reacted almost instantaneously, and ferric ions immediately gave a green colour which after a short time changed into the usual red. At − 100° C., moreover, silver and lead ions gave somewhat delayed reactions, whereas cupric ions reacted instantaneously and manganese and zinc ions almost instantaneously.

These experiments support qualitatively the idea of a connexion between rates of complex formation and valency and electron configurations of the metals in the transition series: (i) for ions with the same electron configuration, for example, Fe^{3+}, Mn^{2+}, higher valency corresponds to lower rate and higher complexity; (ii) in cases of equal valency, ions with half-completed and completed (or nearly completed) electron shells give a much higher rate of complex formation than the remainder of the ions in the transition series (compare, for example, Fe^{3+} with Cr^{3+}, Co^{3+}, and Mn^{2+}, Cu^{2+}, Zn^{2+} with Fe^{2+}, Co^{2+}, Ni^{2+}). This is contrary to the complex-affinity, which increases more or less evenly with the atomic number in the series Cr^{3+}, Fe^{3+}, Co^{3+}, and from Mn^{2+} to Cu^{2+}, before it falls[1,2] to Zn^{2+}.

Some few systems were more thoroughly examined, and the times necessary for reaching a certain degree of reaction determined at different temperatures. As the systems contain several coloured complexes, it was not always possible to determine true degrees of reaction; but the same degrees of reaction could be determined by comparison with an appropriate standard solution with smaller concentration of the metal salt than the reacting mixture. Colours were compared visually, and the constancy of the temperature during the reaction controlled to an accuracy of 0·25° C. by a copper–constantan thermocouple. Only in the chromic thiocyanate system were real velocity constants determined more exactly by other methods[3,4]. The activation energy E_A and frequency factor A in the Arrhenius equation $k = A.\exp(-E_A/RT)$ were calculated in the usual way by plotting ln k against $1/T$ (see table).

System	Ligand taken up	E_A (kcal./mol.)	log A (sec.$^{-1}$)	Solvent ionic strength	Temperature range
Ni^{2+}, py	~1st	~17	~16	CH_3OH, $\mu \sim 0{\cdot}1$	196–218° K.
Co^{2+}, SCN^-	~4th	~15	~17	CH_3OH, $\mu \sim 0{\cdot}05$	181–192° K.
Fe^{3+}, SCN^-	1st	~12·7	~14	CH_3OH, $\mu \sim 0{\cdot}01$	190–199° K.
Cr^{3+}, SCN^-	1st	25·2 ± 0·2	13·6 ± 0·2	H_2O, $\mu \sim 0{\cdot}1$	298–348° K.
		25·2 ± 0·2	13·3 ± 0·2	H_2O, 1 N $NaClO_4$	
"	6th	~25	~13	H_2O, μ var.	288–298° K.

The results suggest that most complex-reactions are instantaneous at room temperature due to a high value of the frequency factor rather than a low activation energy.

The experiments are being continued, and we hope in the near future to publish a paper in *Acta Chemica Scandinavica* dealing with the mechanism of complex formation.

Jannik Bjerrum
Knud Georg Poulsen
Chemistry Department A,
Danish University of Technology,
Copenhagen.
Oct. 9.

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Thermodynamics of Three-Component Systems

Although relations of the type

$$(\partial \ln a_1/\partial n_2)_{n_1,n_3} = (\partial \ln a_2/\partial n_1)_{n_2,n_3}, \quad (1)$$

where a is activity, n is number of moles, and the suffixes denote the components, are by no means new[1], they have been little exploited. Further types such as

$$(\partial \ln a_1/\partial n_2)_{a_2,n_3} = (\partial \ln a_2/\partial n_1)_{a_1,n_3} \quad (2)$$

and

$$(\partial \ln a_1/\partial \ln a_2)_{n_1,n_3} = -(\partial n_2/\partial n_1)_{a_2,n_3} \quad (3)$$

do not seem to appear in the literature at all, though they are sometimes more convenient to use than equation (1). Despite their neglect, these cross-differentiation relations provide a versatile tool in the study of three-component and more complicated systems, as the brief survey in this communication will indicate. They can be generalized by replacing the ln$a$'s by any partial molal quantities. Perhaps the most important conclusion is that, from measurements of the solvent activity only, it is possible to calculate the activities of all the other components.

It is usually desirable, as a first stage, to convert the basic relations into mole ratio (molality) or mole fraction form. This has the effect of reducing from two to one the number of constancy conditions applying to each differential coefficient, since all the variables are now intensive. Equation (1), for example, can be written:

$$(\partial \ln a_1/\partial r_{23})_{r_{12}} = (\partial \ln a_2/\partial r_{13})_{r_{23}}, \quad (4)$$

(where r_{ij} is n_i/n_j), or if component 3 is taken as solvent,

$$(\partial \ln a_1/\partial m_2)_{m_1} = (\partial \ln a_2/\partial m_1)_{m_2}, \quad (5)$$

(where m is molality).

The next stage in most applications is to integrate the relations. Thus (4) integrated at constant r_{13} gives

$$\left\{\ln(a_1/a_1^*) = \int_{r_{23}^*}^{r_{23}} (\partial \ln a_2/\partial r_{13})_{r_{23}}\, dr_{23}\right\}_{r_{13}} \quad (6)$$

(asterisk denotes lower limit of integration). If a_2 has been measured as a function of composition, that is, of r_{13} and r_{23}, this equation gives the variation of a_1 with r_{23} at constant r_{13}. Sometimes, too, by a suitable choice of lower limit, a_1^* becomes a known function, and a_1 is then known absolutely. There are two principal cases:

(1) If a_1 is defined by reference to an infinitely dilute solution in component 2, for example so that $a_1 \to r_{13}$ as $r_{23} \to \infty$ (supposing component 1 to be non-dissociating), then,

$$\left\{\ln(a_1/r_{13}) = \int_{\infty}^{r_{23}} (\partial \ln a_2/\partial r_{13})_{r_{23}}\, dr_{23}\right\}_{r_{13}}, \quad (7)$$

which gives a_1 absolutely. There is a similar equation for a_2 in terms of a_3. This is the result mentioned above, namely, the determination of a_1 and a_2 from measurements of a_3 only. Hitherto it has generally

been supposed that the best that can be achieved is to calculate the third activity when two have been measured.

(2) If a_1 is known for the binary system consisting of components 1 and 3, then we may take $r_{23}^* = 0$ (zero concentration of component 2) as the lower limit of integration, obtaining

$$\left\{\ln(a_1/a_1^0) = \int_0^{r_{23}} (\partial \ln a_1/\partial r_{13})_{r_{23}}\, dr_{23}\right\}_{r_{13}}, \qquad (8)$$

where a_1^0 is the value of a_1 at $r_{23} = 0$.

The difficulties arising at the limits in equations (7) and (8) can be resolved by introducing activity and osmotic coefficients.

The cross-differentiation relations can be applied to a wide variety of systems, for example, ternary liquid mixtures, ternary alloys, solutions of solids in mixed solvents, etc. We may mention especially:

(1) *Aqueous solutions of two electrolytes.* According to equation (7), suitably modified for dissociating species, vapour pressure measurements alone suffice to give the activity coefficients of *both* electrolytes in the mixture. Hitherto no general method has been available for such mixtures. A practical example will be given in a forthcoming paper by Glueckauf, McKay and Perring[2], who have re-interpreted Owen and Cooke's data[3] for lithium chloride – potassium chloride mixtures.

Furthermore, the cross-differentiation relations throw new light on Harned's rule[4]:

$$\ln\gamma_1 = \ln\gamma_{1(0)} - \alpha_{12}\, m_2 \qquad (9)$$

$$\ln\gamma_2 = \ln\gamma_{2(0)} - \alpha_{21}\, m_1, \qquad (10)$$

(where γ is activity coefficient, and $\gamma_{(0)}$ is activity coefficient of a solution of a single component at the same ionic strength μ as the mixture; α_{12} and α_{21} are constant at constant μ). If electrolytes 1 and 2 are of the same valency type, it can be shown that $\alpha_{12} + \alpha_{21}$ is a constant independent of μ, even though α_{12} and α_{21} individually may vary with μ; there is a similar relation for mixed valency types (cf. Glueckauf, McKay and Mathieson[5]). Also, if, say, equation (9) has been established experimentally, then γ_2 can be obtained with the aid of equation (5), without assuming a law of the form of (10). We have (for 1 : 1-electrolytes):

$$(\partial \ln\gamma_2/\partial m_1)_{m_2} = (\partial \ln\gamma_1/\partial m_2)_{m_1}$$

$$\text{or } (\partial \ln\gamma_2/\partial \mu)_{m_2} = (\partial \ln\gamma_1/\partial \mu)_{m_1}$$

$$= d\ln\gamma_{1(0)}/d\mu - \alpha_{12} - m_2 d\alpha_{12}/d\mu, \qquad (11)$$

which can be integrated between limits $\mu = m_2$ and $\mu = m_1 + m_2$ to give γ_2.

(2) *Partition equilibria.* Most treatments of the partition of a solute between two solvents make the approximation of assuming that the two solvents are completely immiscible. We can then apply the simple equation,

$$Ka = a', \qquad (12)$$

for the partitioned solute (K is partition constant, $'$ distinguishes one of the phases). If, however, there is some degree of mutual solubility, then each phase becomes a ternary phase. It can be shown that the effects produced can be handled by introducing additional factors into equation (12):

$$Ka \exp I = a' \exp I', \qquad (13)$$

where I and I' are integrals similar to that in equation (6), and a and a' are now the activities of the solute in suitable standard states, for example, in solution in the two pure solvents. This approach has proved useful in studying various uranyl nitrate – water – organic solvent systems[6].

(3) *Ion exchange equilibria.* The resin phase in ion exchange equilibria is sometimes treated in an over-simplified way, neglecting, for example, variations in the degree of swelling, that is, the water content, with the conditions[7]. The influence of such factors on the activities of the 'resinates' can be estimated by isopiestic experiments with the aid of equations derived from (3).

An alternative treatment of the thermodynamics of ternary systems has recently been given by Darken[8]. His procedure is (in effect) to integrate equations of the type

$$\partial G/\partial n_i = \text{constant} + RT\ln a_i, \qquad (14)$$

to give G (the Gibbs free energy), and then to obtain other activities by differentiating again with respect to other n's. This approach, though similar fundamentally to the present one, does not seem to lend itself so readily to the kind of practical applications considered here.

It is intended to give a fuller account of the properties and use of the cross-differentiation relations elsewhere.

I am indebted to the Director, Atomic Energy Research Establishment, for permission to publish this letter, and to Dr. E. Glueckauf for many valuable discussions.

H. A. C. McKay

Atomic Energy Research Establishment,
Harwell, Didcot,
Berks.

Sept. 28.

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Mechanics of the Animal Water-Bottle

THE increasing popularity of the inverted bottle and drinking spout for watering small laboratory animals has brought to light potential drawbacks: it is well, therefore, to consider the physical (including the mechanical) principles governing this simple system, in order that these drawbacks may be overcome. No attempt is made to describe practical devices, of which there is a great number: a comprehensive account of these is being prepared for publication elsewhere.

A bottle, which should be sufficiently capacious in relation to the needs of the animal, is fitted with a suitable spout or drinking tube, filled with water and inverted. The animal licks or sucks water from the spout, air entering the bottle to replace the water. The water does not run out of its own accord, provided certain conditions are observed.

(1) The internal diameter of the tube should be ¼–⅜ in. (6–9 mm.) and constricted at the distal end to a hole of diameter about ⅛ in. (3 mm.)[1]. A smaller tube will be subject to air locks: a larger tube is unnecessary and is liable to spontaneous emptying.

(2) The connexion of the tube to the bottle must be air-tight. The slightest leak will cause the bottle to empty spontaneously.

(3) The bottle must not be too large: 500 c.c. is about the limit. An increase in the volume of air inside the bottle will lead to expulsion of water, and there are several ways (apart from leakages around the bung) in which this can happen when the animal is not drinking: (*a*) An increase in temperature of 1° C. will cause an increase in volume of approximately 0·3 per cent, that is, 0·3 c.c. for every 100 c.c. of air in the bottle. (*b*) A fall in atmospheric pressure of 0·1 in. (2·5 mm.) mercury will cause a similar increase of volume; neither of these results in serious leakage normally. (*c*) Shaking the bottle; movement of the bottle may cause the volume of water expelled to exceed the volume of air admitted: a further volume of air will then be drawn into the bottle, and the process may be repeated until the bottle is empty.

Leakage from any of these causes depends on the increase in volume of the air in the bottle being greater than the drop of water which can hang on the end of the tube: if the drop does not fall off, a subsequent decrease in volume (such as will immediately follow an increase resulting from shaking) will draw the drop back into the tube, provided the drop covers the aperture in the end of the tube.

Drop-size depends on a number of factors, the most important of which are the material comprising the tube, and the shape of its extremity. Glass has been found to carry a larger drop than other materials, metal being the least satisfactory; while a small terminal expansion can increase the drop-size considerably.

If the tube, instead of being vertical, is at an oblique angle (as frequently happens when the bottle is held outside the cage) the drop of water will not cover a centrally placed aperture. It is necessary, therefore, to make the terminal aperture at the most dependent part of the tube, so that contraction of the air inside the bottle will suck back the drop of water, rather than air (which may lead to spontaneous emptying).

W. Lane-Petter

Laboratory Animals Bureau,
Medical Research Council Laboratories,
Holly Hill, Hampstead,
London, N.W.3.
Nov. 1.

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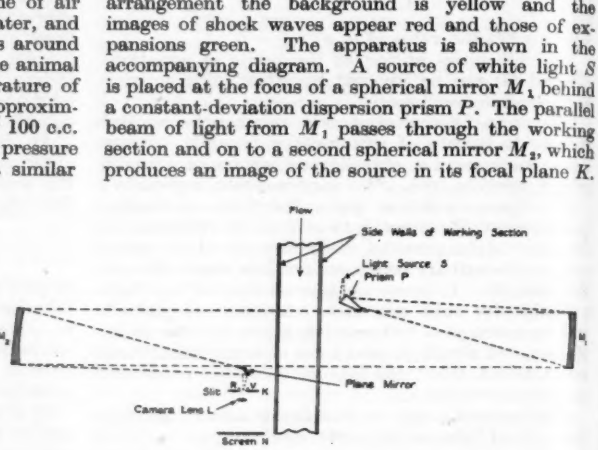
A *Schlieren* Apparatus giving an Image in Colour

At the last two annual exhibitions of the Royal Photographic Society, we have shown colour transparencies of the high-speed flow past aerofoils. In accounts in *Nature* of both exhibitions[1], the method used in taking these photographs is erroneously described as employing polarized light. This leads us to suppose that the technique is not widely known. It is simple, and has been found to be particularly useful for visual observations of the flow in a high-speed wind tunnel.

The arrangement is such that, when the density in the working section is uniform, the image is uniformly coloured and evenly illuminated; when there is a density gradient the corresponding part of the image changes colour. Thus, with a typical arrangement the background is yellow and the images of shock waves appear red and those of expansions green. The apparatus is shown in the accompanying diagram. A source of white light S is placed at the focus of a spherical mirror M_1 behind a constant-deviation dispersion prism P. The parallel beam of light from M_1 passes through the working section and on to a second spherical mirror M_2, which produces an image of the source in its focal plane K.



The image of the source thus formed consists of a series of coloured bands, and a slit placed in the focal plane is adjusted to cut off all the light apart from that of a particular colour. A camera lens L placed behind the slit is then used to produce an image of the working section on a screen N. When the density gradient in the working section is uniform, the image on the screen is monochromatic and uniformly illuminated. But, when the density gradient in some part of the working section differs from that in the surrounding field, the corresponding image of the source shifts relative to the slit and the corresponding part of the image on the screen changes colour. The differential refraction effect due to the differing wave-lengths being negligible compared with the overall refraction of the beam, the operation of the apparatus is analogous to that of a Toepler arrangement, except that the image on the screen is one of different colours instead of one of light and shade.

The method has the advantages over the Toepler method that the illumination is in no part of the field so low that the eye becomes insensitive, and that the eye is, in general, more sensitive to changes of hue than to changes of illumination.

It is possible that the method could be used quantitatively by moving the slit across until a particular colour disappears from a point in the image on the screen, and thus determining the displacement of the corresponding image of the source in the focal plane K of M_2.

D. W. Holder
R. J. North

Aerodynamics Division,
National Physical Laboratory,
Teddington, Middlesex.
Nov. 14.

[1] *Nature*, **166**, 645 (1950); **168**, 689 (1951).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Monday, March 17

OPERATIONAL RESEARCH CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Annual Open Meeting on "Marshalling and Queueing".

UNIVERSITY OF LONDON (in collaboration with the ROYAL INSTITUTE OF INTERNATIONAL AFFAIRS, at the London School of Economics and Political Science, Houghton Street, Aldwych, London, W.C.2), at 5 p.m.—Dr. James Conant: Stevenson Memorial Lecture.*

SOCIETY OF CHEMICAL INDUSTRY, LONDON SECTION (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.30 p.m.—Scientific Papers.

Tuesday, March 18

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Edward Salisbury, F.R.S.: "Germination". (Further Lectures on March 25 and April 1.)

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. A. J. Brayshaw: "The Stability of Marriage".*

INSTITUTE OF FUEL (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. L. Clegg and Mr. J. Price Walters: "Fuel, Heat and Power Auditing".*

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5.30 p.m.—Prof. E. G. Bowen: "The Culture Provinces of Celtic Britain in the Dark Ages".

INSTITUTE OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Mr. G. Noble: "The Fawley Refinery".

SOCIETY OF DYERS AND COLOURISTS, SCOTTISH SECTION (at St. Enoch Hotel, Glasgow), at 7 p.m.—Annual General Meeting; at 7.30 p.m. (joint meeting with the SCOTTISH SECTION of the TEXTILE INSTITUTE).—Mr. J. Zonnenberg: "Some Recent Developments in Starch Products and their Application to Sizing, Finishing and Printing".

Wednesday, March 19

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. C. W. Marshall: "Supplementary Sources of Power—Wind, Volcanic Heat, Sun and Tide".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Dr. M. V. Wilkes: "World-wide Oscillations in the Earth's Atmosphere" (Symons Memorial Lecture).

INSTITUTE OF PHYSICS, LONDON AND HOME COUNTIES BRANCH (at 47 Belgrave Square, London, S.W.1), at 5.30 p.m.—Dr. W. R. Harper: "The Volta/Helmholtz Hypothesis of Frictional Electricity".

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Dr. E. G. Ritchie: "Research into Steam and Heat Utilization in Industry".

INSTITUTION OF STRUCTURAL ENGINEERS, LANCASHIRE AND CHESHIRE BRANCH (in the Reynolds Hall, College of Technology, Manchester), at 6.30 p.m.—Dr. G. G. Meyerhof: "Some Aspects of Soil Mechanics, with reference to Foundations".

ROYAL INSTITUTE OF CHEMISTRY, LONDON AND SOUTH-EASTERN COUNTIES SECTION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Dr. B. C. Saunders: "Some Aspects of the Organic Chemistry of Phosphorus and Fluorine".

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS' SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. R. A. Jones: "Industrial Electronics".

Thursday, March 20

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.45 p.m.—Scientific Papers.

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.15 p.m.—Election of Fellows; Mr. I. Chester Jones: "The Disappearance of the X Zone of the Mouse Adrenal Cortex during First Pregnancy"; Mr. G. E. Fogg: "The Production of Extracellular Nitrogenous Substances by a Blue-green Alga".

INSTITUTION OF MINING AND METALLURGY (at the Geological Society of London, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

LINNEAN SOCIETY OF LONDON (joint meeting with the SYSTEMATICS ASSOCIATION, at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Growth and Systematics" (to be opened by Prof. W. E. Le Gros Clark, F.R.S., Dr. R. M. C. Eagar and Dr. R. Melville).

LONDON MATHEMATICAL SOCIETY (at the Royal Astronomical Society, Burlington House, Piccadilly, London, W.1), at 5 p.m.—Prof. J. W. Miles: "Transformation of the Equations of Unsteady Supersonic Flow".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. G. Bullough: "English Literature and Science in the Seventeenth Century". (Further Lectures on March 27 and April 3.)

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. D. Bolton: "The Individual-Generator System as applied to the Tandem Cold-Strip Mill"; Mr. E. J. R. Hardy: "The Magnetic-Fluid Clutch"; Mr. J. C. Shaw: "The Measurement of Electrical Activity in the Human Body".

TELEVISION SOCIETY (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 6.30 p.m.—Prof. H. M. Barlow: "Guided Waves" (Fleming Memorial Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at the Royal Army Medical College, Millbank, London, S.W.1), at 7.30 p.m.—Laboratory Meeting.

CHEMICAL SOCIETY, EDINBURGH SECTION (joint meeting with the ROYAL INSTITUTE OF CHEMISTRY and the SOCIETY OF CHEMICAL INDUSTRY, at the North British Station Hotel, Edinburgh), at 7.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Chemistry of the Hemicelluloses".

Friday, March 21

BIOCHEMICAL SOCIETY (at the National Institute for Medical Research, Mill Hill, London, N.W.7), at 10.30 a.m.—Scientific Papers; Annual General Meeting.

ROYAL SOCIETY OF MEDICINE, EPIDEMIOLOGY AND STATE MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 4.30 p.m.—Discussion on "Health—its Study and Culture in the Nation To-day" (Speakers: Sir Alan Rook, Dr. T. A. Lloyd-Davies and Major M. M. Lewis).

INSTITUTE OF NAVIGATION (at the Royal Geographical Society, 1 Kensington Gore, London, S.W.7), at 5 p.m.—Commander C. E. N. Frankcom: "Navigation and the Ocean Weather Services".

INSTITUTE OF FUEL, SCOTTISH SECTION (joint meeting with the SCOTTISH ASSOCIATION OF GAS MANAGERS, at the Royal Technical College, Glasgow), at 6 p.m.—Dr. F. J. Dent: "Some Aspects of Complete Gasification of Coal".

BRITISH INSTITUTE OF RADIOLOGY (in the Reid-Knox Hall, 32 Welbeck Street, London, W.1), at 6.30 p.m.—Mr. W. A. Langmead: "The Schmidt Camera—its Possibilities and Limitations in Photofluorography".

INSTITUTE OF PHYSICS, INDUSTRIAL RADIOLOGY GROUP (at 47 Belgrave Square, London, S.W.1), at 6.30 p.m.—Discussion on "The Value of Limitation of Standardization" (Speakers: Mr. G. Weston, Dr. H. M. Glass and Mr. W. E. Schall).*

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. B. Bleaney: "Spectroscopy at Centimetre Wave-lengths".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7 p.m.—Annual General Meeting; at 7.30 p.m.—Dr. N. Evers: "The Physico-Chemical Aspects of Drug Administration".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Sir Edward Salisbury, F.R.S.: "Orchids".

Saturday, March 22

NUTRITION SOCIETY (in the Physiology Lecture Theatre, The University, Manchester), at 10.30 a.m.—Papers on "Diet in relation to Renal and Cardio-Vascular Disease".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER or ASSISTANT LECTURER IN MATHEMATICS—The Registrar, University College, Leicester (March 22).

LECTURER IN CHEMISTRY—The Principal, Wigan and District Mining and Technical College, Wigan (March 29).

SCIENTIST, Grade I (with a good honours degree in chemistry, and considerable experience of research, particularly in the field of physical chemistry) to assist in the supervision of work in the Chemistry Department (Ref. TT.441), a SCIENTIST, Grade II (with a good honours degree in chemistry or physics) for research on the application of X-ray techniques to coal, associated materials and by-products, and to lead a small team engaged on infra-red, ultra-violet and emission spectroscopy (Ref. TT.442), and SCIENTISTS, II/III, as physicists, chemists, chemical engineers (Ref. TT.443), in the Central Research Establishment, Stoke Orchard, Cheltenham—The National Coal Board, Establishments (Personnel), Hobart House, Grosvenor Place, London, S.W.1, quoting the appropriate Ref. No. (March 29).

SENIOR LECTURER and a LECTURER IN PHYSIOLOGY, and a LECTURER IN SOCIAL MEDICINE, at the University of Malaya, Singapore—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (March 30).

AGRICULTURIST (with a B.Sc. degree in agriculture, and a preference for experimental and research work) in the Department of Research and Specialist Services—The Secretary, Southern Rhodesia Government, 429 Strand, London, W.C.2 (March 31).

LECTURERS (with special qualifications in organic chemistry, or inorganic and physical chemistry) and ASSISTANT LECTURERS IN THE DEPARTMENT OF CHEMISTRY—The Secretary, The University, Edinburgh (March 31).

EDUCATIONAL PSYCHOLOGIST—The Chief Education Officer, Education Office, Margaret Street, Birmingham 3 (April 1).

PRINCIPAL LECTURERS, a SENIOR LECTURER, and LECTURERS IN MECHANICAL ENGINEERING, a SENIOR LECTURER IN APPLIED CHEMISTRY, a LECTURER IN BALLISTICS, LECTURERS IN ELECTRICAL ENGINEERING, and DEMONSTRATORS IN PHYSICS, BALLISTICS, CHEMISTRY, METALLURGY, and ELECTRICAL AND MECHANICAL ENGINEERING, at the Military College of Science, Shrivenham, Swindon—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4130/52 (April 3).

PRINCIPAL SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics and some knowledge of electro-acoustics and electronics, with experience in the planning of research), in the R.A.F. Acoustics Laboratory in London under the Air Ministry—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4129/52 (April 3).

ASSISTANT (Grade B) IN CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, Woolwich, London, S.E.18 (April 5).

LECTURERS (3) IN THE DEPARTMENT OF ANATOMY, University of the Witwatersrand, Johannesburg—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (April 7).

METEOROLOGISTS in the Meteorological Service of the Air Department in New Zealand—The High Commissioner for New Zealand, 415 Strand, London, W.C.2, quoting *Nature*, Ref. 3/47/6 (April 7).

UNIVERSITY DEMONSTRATOR IN THE DEPARTMENT OF CHEMICAL ENGINEERING—The Secretary of the Appointments Committee of the Department of Chemical Engineering, Tennis Court Road, Cambridge (April 18).

ASSISTANT LECTURER IN ANATOMY, to undertake teaching and research in vertebrate embryology—The Secretary, University College, Gower Street, London, W.C.1 (May 1).

FOULERTON RESEARCH FELLOWSHIP IN MEDICINE—The Assistant Secretary, Royal Society, Burlington House, Piccadilly, London, W.1 (May 1).

AGRICULTURAL ENGINEER, Gold Coast, for work in connexion with soil and water conservation in the Northern Territories of the Gold Coast, principally the supervision of earth-work contracts in dams and terracing—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27329/28.

ANALYTICAL CHEMISTS (Experimental Officer grade) at the Atomic Energy Research Establishment, Harwell—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.78/52A/MC.

ASSISTANT LECTURER (Grade B) IN THE DEPARTMENT OF MATHEMATICS, College of Technology and Commerce, Cardiff—The Director of Education, City Hall, Cardiff.

CURATOR OF THE BOTANIC GARDENS, Entebbe—The Crown Agents for the Colonies, 4 Millbank, London, S.W.1, quoting M.27821.A.

ENGINEER or CHEMIST (honours graduate, preferably doctorate level) to undertake research investigations in connexion with the preparation of coal or on its constitution and chemical utilization—The Secretary, Research Council of Alberta, University of Alberta, Edmonton, Alba., Canada.

EXPERT IN SERUMS AND VACCINES (with degree with previous experience in scientific research institutes or bacteriological laboratories for not less than five years) to take charge of Veterinary Laboratory under the Directorate of Veterinary Services, Government of Iraq—The Ministry of Labour and National Service, Almack House, 26 King Street, London, S.W.1, quoting A.12/ME/421/51.

LECTURER IN CHEMISTRY (with a good honours degree of a British university and able to teach up to Special Degree standard, particularly in inorganic and physical chemistry)—The Principal, Kingston Technical College, Kingston Hall Road, Kingston, Surrey.

LECTURER IN ZOOLOGY AND PHYSIOLOGY, a LECTURER IN APPLIED OPTICS, and an ASSISTANT (Grade B) IN PRACTICAL MATHEMATICS—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15.

MALARIA ENGINEER, East Africa High Commission, to plan projects for drainage and control of natural waters in connexion with the prevention of malaria and other vector-borne diseases—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27322/237.

RESEARCH ASSISTANT, temporary (with an honours degree in biology, and experience of, or inclination towards, the mathematical aspects of biological problems) IN THE DEPARTMENT OF TSETSE CONTROL, Gold Coast, to compile and analyse data on tsetse incidence with the purpose of evaluating the necessity for various control methods and of studying the biology of tsetse species so as to develop new control methods—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27059/311.

SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or chemistry, or equivalent qualification) at the Atomic Energy Research Establishment, Harwell, to work on term analysis of complex spectra and to assist in work on isotope shifts and hyperfine structure, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.89/52A.

SENIOR RESEARCH STUDENTSHIP IN ENGINEERING—The Registrar, University College, Singleton Park, Swansea.

SENIOR SCIENTIFIC OFFICER (Botanist), a SCIENTIFIC OFFICER (Botanist), and a SCIENTIFIC OFFICER (Chemist) to work on microbiology of mangrove swamp soils, at the Rokupr Rice Research Station, Sierra Leone—The Under-Secretary of State, Research Department (S.610), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1

REPORTS and other PUBLICATIONS

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British Standard 490 : 1951, Rubber Conveyor and Elevator Belting. Pp. 19. 3s. net. British Standard 1800 : 1951, Methods for the Analysis of Raw Copper. Pp. 44. 5s. net. (London : British Standards Institution, 1951.) [1212

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Department of Scientific and Industrial Research. Report of the Forest Products Research Board with the Report of the Director of Forest Products Research for the Year 1949. Pp. v+50+8 plates. (London : H.M. Stationery Office, 1951.) 2s. 6d. net. [1712

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